The American Journal of Surgery

EDITED BY THURSTON SCOTT WELTON, M.D.

December 1941

Orthopedics . General Surgery

Gastrointestinal Surgery . Obstetrics

Thoracic Surgery . New Instruments

Special Monograph

Cancer of the Gums (Gingivae) By HAYES MARTIN

INDEX TO VOLUME LIV IN THIS ISSUE

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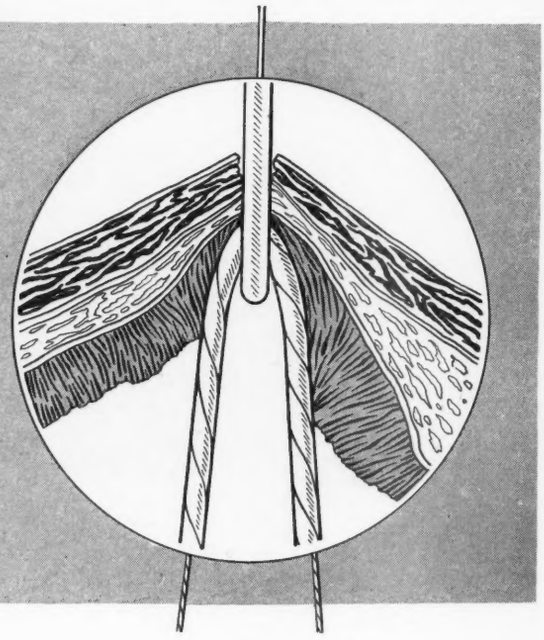

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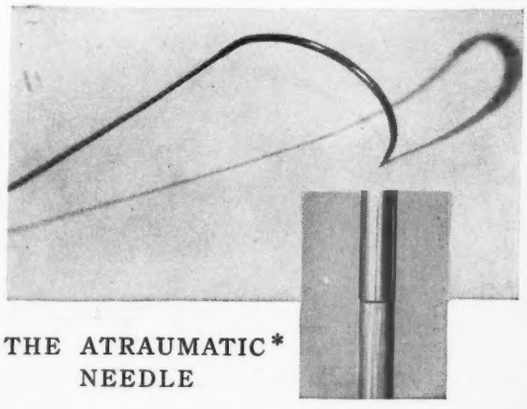

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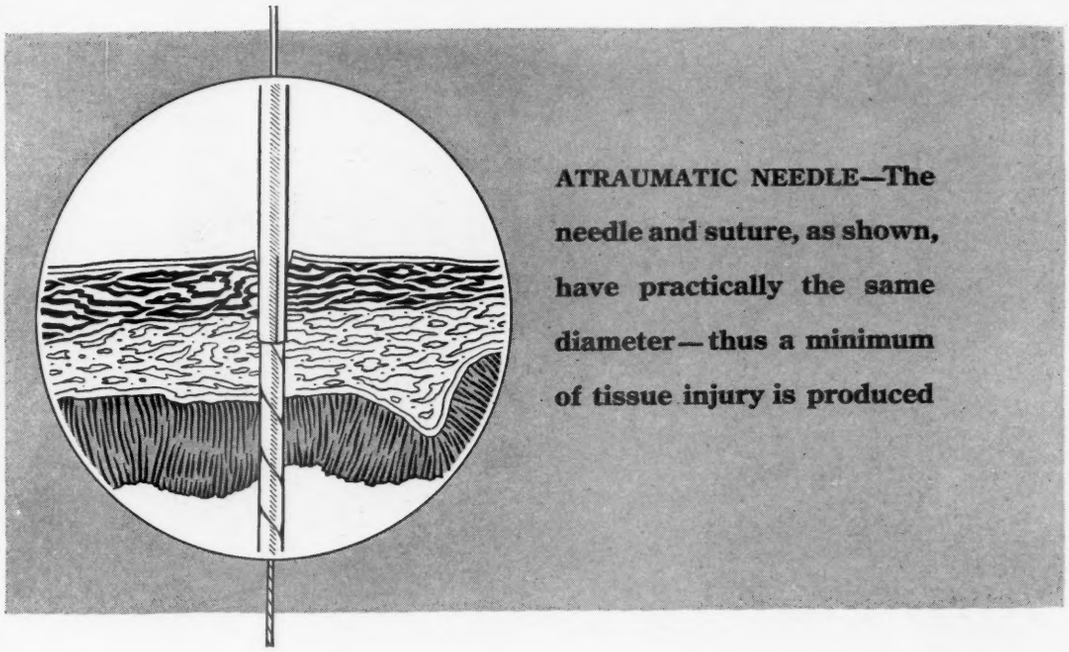

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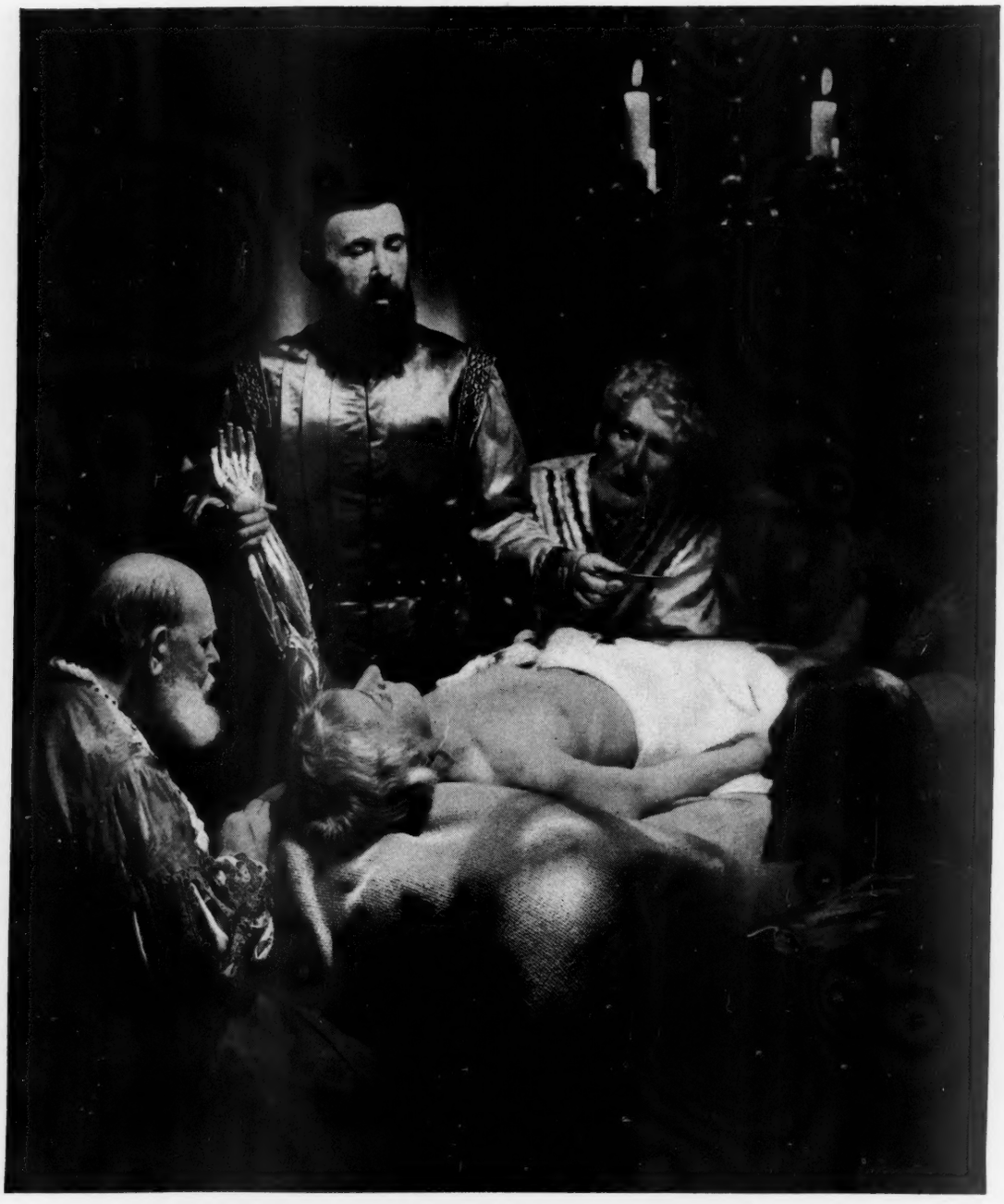

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NEW SERIES VOL. LIV — *Contents • December, 1941* — NUMBER Three

Editorials

Medical Students, Deans and Deferment 587
Two Unusual Biographies: Park and Welch 588

Original Articles

Juvenile Osteochondreal (Chondro-Epiphysitis) Hypothyroidism
Robert L. Schaefer and Frank H. Purcell 589
Bone Drilling in Resistant Chronic Ulcers. A New Principle . . . . . *Fred H. Albee* 605
Differential Diagnosis of the "Painful Hip" in Childhood . . . . . *Paul C. Colonna* 609
Primary Bronchogenic Carcinoma of the Lung. A Clinical and Roentgen Study of Thirty-eight Cases over a Period of Twelve Years . . *Harry A. Olin and Clinton A. Elliott* 614
Pathology of Appendiceal Stump with Suggestions for Prophylaxis . . . . . *V. L. Schrager* 629
Emergency Control of Postpartum Hemorrhage. Experience with a Supplementary Technic . . . . . *Clarence C. Briscoe and Robert A. Wilson* 634
Treatment of Pelvic Infection by Iontophoresis of a Choline Compound . *Alexander H. Rosenthal* 639
Surgical Treatment of Axillary Hidrosadenitis Suppurativa . . . . . *Harry B. Macey* 643

Contents Continued on Page 3

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NEW SERIES VOL. LIV Contents • December, 1941 NUMBER Three

Postoperative Gastric Drainage. Quantitative Study for an Indication of Re-establishment of Gastrointestinal Motility Following Gastric Operations *James P. Warbasse, Jr.* 648
Prevention of Postoperative Meningitis by Intracranial Implantation of Powdered Sulfanilamide . . . . . *Yale D. Koskoff and Norman M. Wall* 653
Biochemical Aspects of Preoperative and Postoperative Treatment. Its Practical Application . . . . . *Raymond Green* 659
Peritoneoscopy. With Special Reference to Widening Its Applications . . . *Joseph E. Hamilton* 668
Healing of the Operative Wound in Syphilitic Women . . . *Henry C. Falk and Ivan Kempner* 674
Congenital Duodenal Obstruction . . . . . *Russell O. Lyday* 678
Postoperative Evisceration. Résumé of the Literature and Report of Five Cases *Morris L. Bobrow* 682
Ultraviolet Irradiation of Autotransfused Blood in the Treatment of Puerperal Sepsis . . . . . *E. W. Rebbeck* 691
Treatment of Surgical and Traumatic Shock with a Citrated Plasma-Saline Mixture *Charles Stanley White, J. Lloyd Collins and Jacob J. Weinstein* 701
New Operative Procedure for Dupuytren's Contracture . . . . . *Elias Lincoln Stern* 711
Preparation of Superficial Wounds for Skin Grafting by the Local Use of Sulfanilamide and Sulfanilamide-Allantoin Ointment *J. Ross Veal, Roy G. Klepser and Michael P. DeVito* 716
Use of a Plaster Slipper in the Management of Simple Fractures of the Toes *Joseph E. Macmanus* 721

Case Reports

Obstruction of the Common Bile Duct by a Detached Piece of Liver *N. Frederick Hicken and J. LeRoy Kimball* 723
Subcutaneous Rupture of Meckel's Diverticulum . . . . . *H. A. Gamble* 727
Migration of Projectiles in Blood Vessels. Report of an Unusual Case . . . . *George J. Laird* 729
Multiple Shell Wounds. A Case Report . . . . . *Alfred J. Barbano* 731
Avulsion of the Distal Tendon of the Biceps Brachii . . . . . *Walter E. Sharpe, Jr.* 733
Pseudofracture of the Tibia. Report of Two Cases . . . *J. Lloyd Tabb and Bernard D. Packer* 737
Recurring Pyogenic Osteomyelitis. Report of a Case with a Forty-seven Year Quiescent Period between Attacks . . . . . *Bernard N. E. Cohn* 741
Adenoma of Langerhans' Islet of the Pancreas . . . . . *Perry G. Vayo and George T. Bodon* 744
Diagnostic Points in Intra-abdominal Pregnancy. Report of a Case *Morris Weintrob and David I. Weintrob* 747
Mobile Cecum with Left Hydrocele. Case Report . . . . . *W. Houston Toulson* 753

New Instruments

Dog Surgery. Descriptions of Technic for Anesthesia and of a Respirator for Thoracic Surgery Practice . . . . . *Thomas Peck Butcher and Clyde O. Merideth, Jr.* 755
Phillip's Recessed Head Screw . . . . . *Arch F. O'Donoghue* 758
Elimination of Air Bubbles from Intravenous Apparatus by a Modification of the Murphy Drip . . . . . *Edward J. Ottenheimer* 759
Modified Braun Perineal Scissors . . . . . *Harold D. Caylor* 760
Selected Book Review 761

Special Monograph

Cancer of the Gums (Gingivae) . . . . . *Hayes Martin* 765
Author Index to Volume LIV 807
Subject Index to Volume LIV 808

General Information on Page 4 *Advertisers Index on 3rd Cover*

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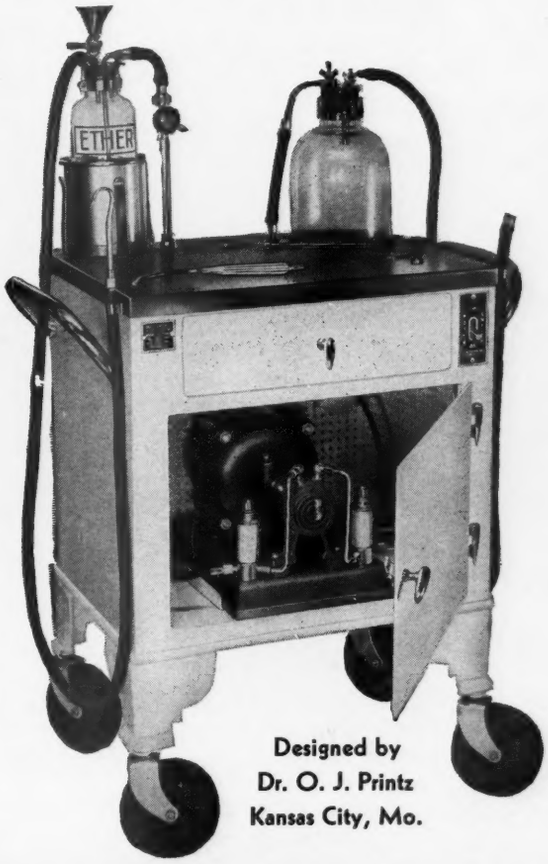

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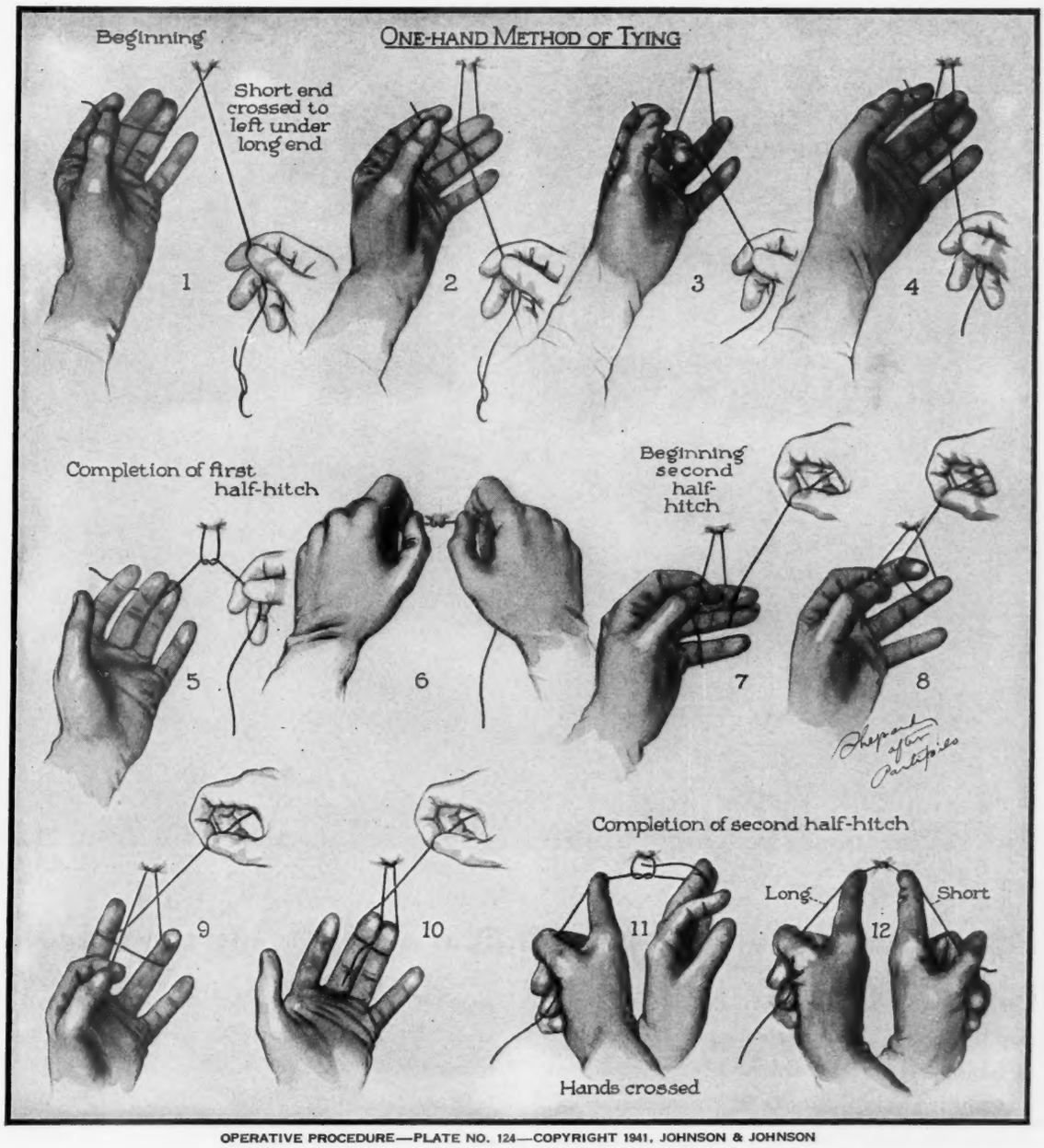

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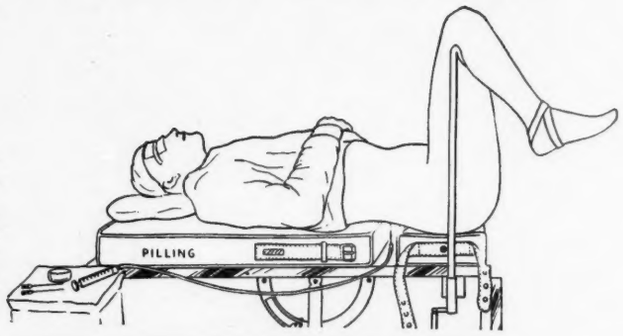

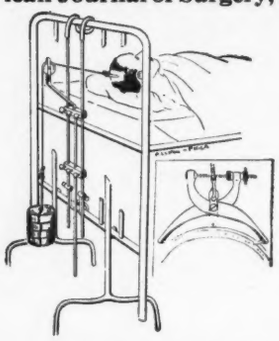

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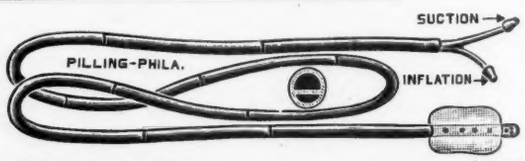

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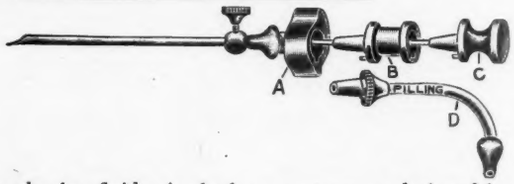

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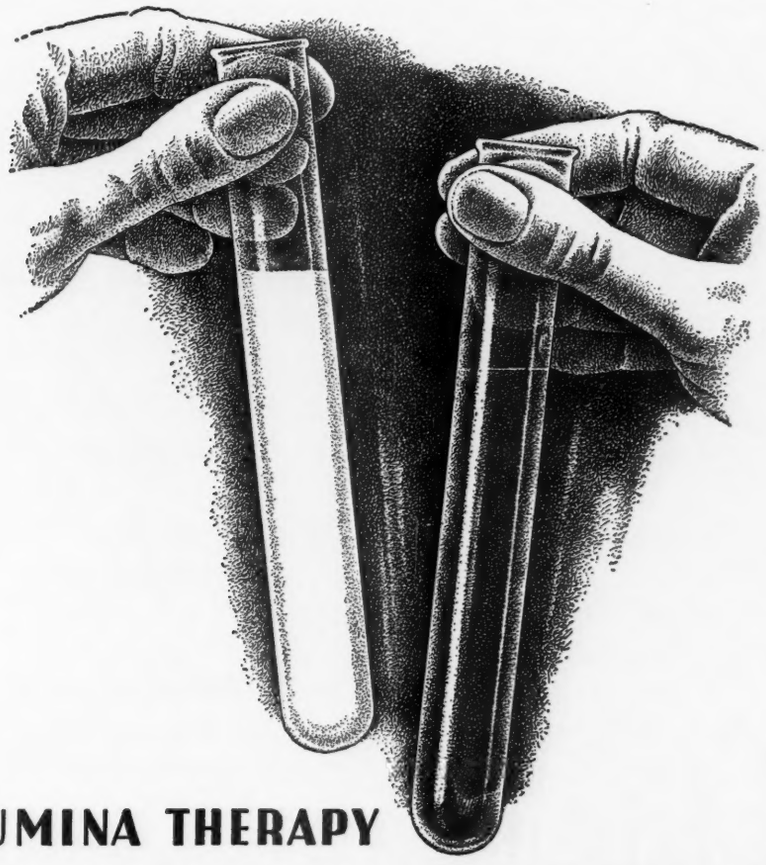

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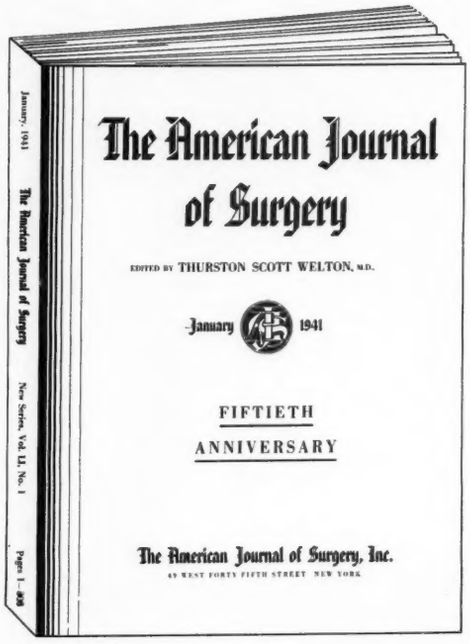
The American Journal of Surgery
EDITED BY THURSTON SCOTT WELTON, M.D.
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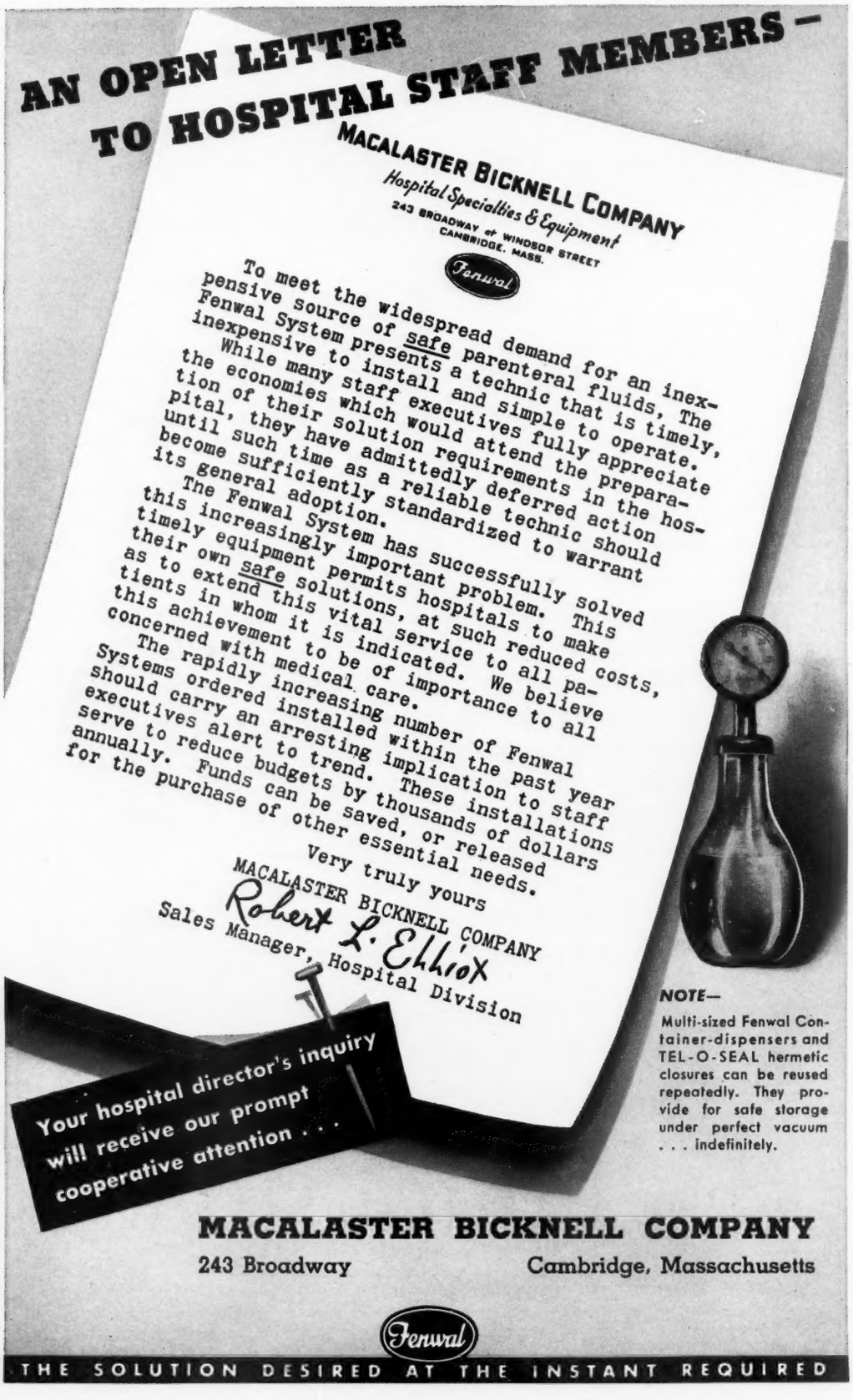
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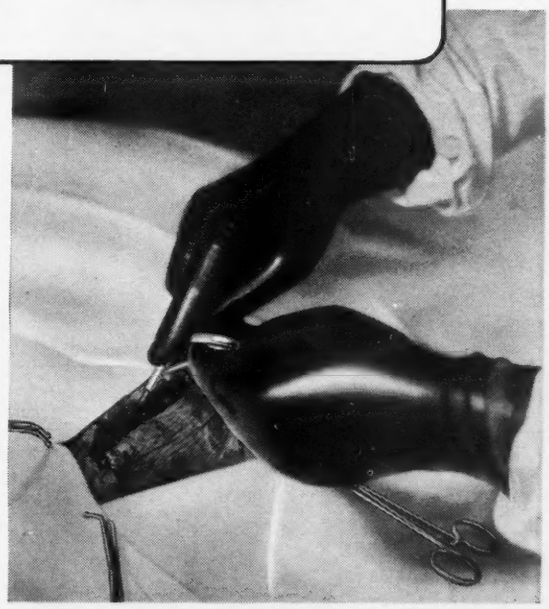

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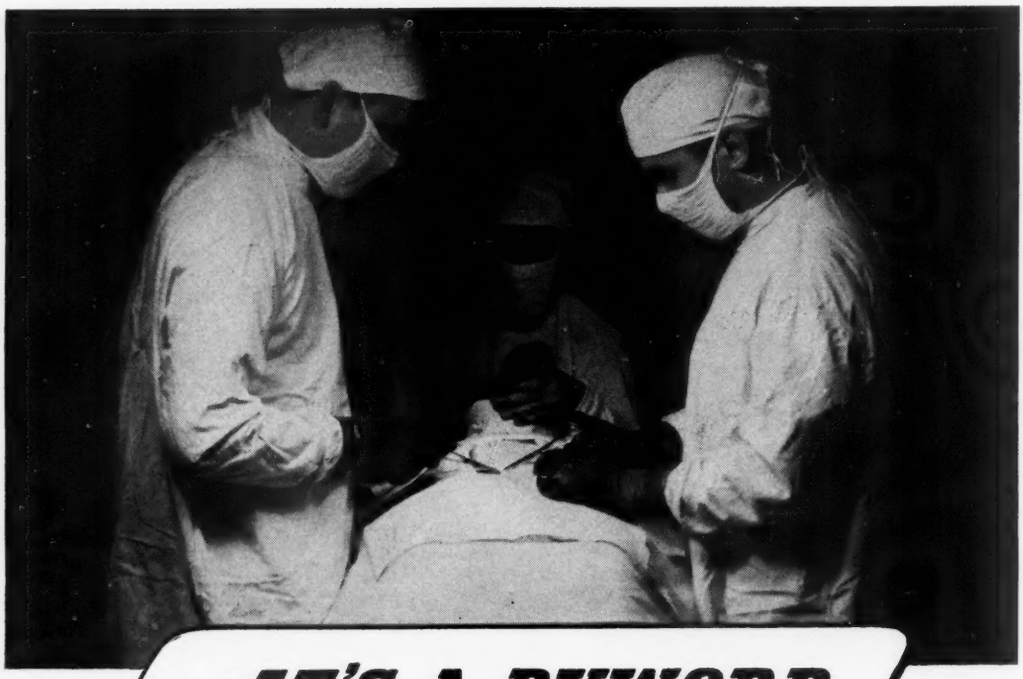

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NEW SERIES VOL. LIV DECEMBER, 1941 NUMBER THREE

Editorials

MEDICAL STUDENTS, DEANS AND DEFERMENT

A FEW months ago there was a great ado concerning medical students and the draft. We wrote editorials on the subject; other scientific publications also carried editorials. The Deans of our Medical Colleges were in somewhat of a dither, fearing a large percentage of the medical students now enrolled would end up in the army. Spokesmen of representative bodies hurried to Washington to meet in conference and "take up" this matter with the right persons. Then, out of a clear sky a solution was found.

Medical students would receive deferment. An opportunity was provided for junior and senior medical students to enroll in the War Department Reserve Pool. This made it possible for them to continue their studies, serve a year's internship, and then be available for military service as medical officers. All hands believed that these upper classmen, *en masse*, would stampede for enrollment. However, the truth is discouraging. To date a very small percentage of these young men have bothered to do their duty. If these students persist in avoiding military service, the Army will lack the medical personnel it will require in the future. Under the Selective Service Act deferment could be ended without discussion or previous notice; and if junior and senior medical students persist in the folly of failing to take advantage of this method whereby they can complete their medical studies, this deferment is sure to come to an abrupt halt.

It has been suggested that the Deans of our Medical Colleges can play an important and active rôle in this situation. They can call the upper classmen together and explain the situation in detail, using words of one syllable; or call each student before them individually and explain the why's and wherefore's and then "turn on the heat."

It is believed that the "authorities" have leaned over backward and have been patient and fair. Now the shoe is on the other foot; and no one will complain if, after a reasonable time, medical students are no longer deferred but are inducted into the Army, unless they apply for commissions as second lieutenants in the Medical Administrative Corps or as ensigns in the Navy.

TWO UNUSUAL BIOGRAPHIES: PARK AND WELCH*

DURING the past few years the book readers of this country have been deluged with books written by physicians. Many of them have been autobiographies. At first some of them reached the best-seller lists. Then the public became tired of reading about medical students, hospital life, gory details of human suffering, and turned to fiction and mystery stories.

In 1925, Harvey Cushing wrote the Life of Sir William Osler. It was awarded the Pulitzer Prize for that year. It is still a model of its class. One would think more physicians would write about the giants in our profession rather than being whimsical about themselves. And so, it was with great joy that we received two books about physicians who helped shape the course of American Medicine.

"The Man Who Lived for Tomorrow—A Biography of William Hallock Park, M.D.," is a delightful biography of the man who, among other great accomplishments, saved the lives of thousands of children by his diphtheria antitoxin. Park did other important things in his life; his innumerable discoveries earned him a place among the immortals in Medicine. This is no place to review the highlights of the work. Wade Oliver, for many years a well known teacher of bacteriology, the author of two volumes of poems and of a delightful small volume, "Stalkers of Pestilence," has written an absorbing, moving, and all in all a delightful biography. Not only will it prove invaluable to future medical historians, but merely as a book to pick up and read it will be found a thing of pleasure.

Simon Flexner and James Thomas Flexner offer "William Henry Welch and the Heroic Age of American Medicine." Simon Flexner was one of Welch's early pupils and was closely associated with his former teacher through most of his life. James Thomas Flexner, son of Simon Flexner, will be recognized for his widely read early American history, "Doctors on Horseback."

Welch needs no introduction to any one of our profession. He was one who lived in our time and whose life and work will be read about and discussed a century from now. A many-sided figure, "Popsy" truly was a character. And the Flexners have done an honest and detailed portrait of this man who was the intellectual father of so many of the greatest scientists in America. We would not venture to predict the work's reception by the average lay reader but we do predict that the Doctor of Medicine will find every chapter good reading.

This is the Holiday Month, the time one exchanges gifts with relatives and friends. Doctors often make gifts of books. This year we recommend these two volumes as just the gift for a colleague or a co-worker. They are the type of books one feels proud to have on the shelves of his library.

* Oliver, Wade W. The Man Who Lived for Tomorrow—Biography of William Hallock Park. New York, 1941. E. P. Dutton & Co. Price $3.75.

Flexner, Simon and Flexner, James Thomas. William Henry Welch and the Heroic Age of American Medicine. New York, 1941. Viking Press. Price $3.75.

Original Articles

JUVENILE OSTEOCHONDREAL (CHONDRO-EPIPHYSITIS) HYPOTHYROIDISM

ROBERT L. SCHAEFER, M.D. AND FRANK H. PURCELL, M.D.
Consulting Endocrinologist, Grace Hospital — Attending Orthopedic Surgeon, Grace Hospital
DETROIT, MICHIGAN

FROM a former study[1] it is the authors' contention that so-called juvenile chondro-epiphysitis is due to neither an inflammatory process nor vascular changes but specifically to hypothyroidism with the consequent lack of its tissue differentiating factor. The confusing terminology of proper names as related to the various joints involved which designate each as a separate clinical entity should be done away with entirely, and the term "chondro-epiphysitis" changed to "osteochondreal hypothyroidism." Basic therapy, we believe, is adequate replacement of desiccated thyroid. Orthopedic treatment, frequently necessary, is adjunctive.

In our former publication such characteristic chondro-epiphyseal changes were found in ninety-one out of 258 clinically proved endocrinopathic patients. Out of this ninety-one all but five were associated with the primary or secondary signs of hypothyroidism, such as mental retardation, characteristic structural changes, delay in the time of appearance of osseous centers, increased blood cholesterol and decreased basal metabolic rates. Thirty-eight patients, or 41 per cent, revealed multiple epiphyseal disturbances. This indicates its generalized character. The following endocrine diagnoses were noted: thirty cases of hypothyroidism, thirty-five cases of adiposogenital pituitarism, twenty-five cases of pituitary dwarfism and one case of eunuchoidism. The osseous findings were made possible through the routine roentgenographic study for osseous development. We deem this a most important diagnostic procedure in endocrine medicine. In a control group of ninety-nine non-endocrine patients in the same age group only 7 per cent revealed comparative Roentgen findings of chondro-epiphyseal disturbance. Only two of the endocrine patients cited had associated clinical symptoms of so-called juvenile osteochondritis.

The requirements for the diagnosis of hypothyroidism, either primary or secondary, are the usual ones: clinical history, developmental delay, decreased basal metabolic rates well below minus 10 per cent, increased blood cholesterol above 200 mg. per 100 cc. blood, and delay in osseous development. In addition, we now include chondro-epiphyseal changes as indicated in this publication. Because of the complexity of the entire endocrine mechanism uniglandular disturbances are comparatively rare. The present trend in diagnosis is pluriglandular as is the treatment. Therefore, by primary hypothyroidism is meant a clinical disturbance in which no signs of dysfunction can be determined except those referring to the thyroid. By secondary hypothyroidism we imply that the primary failure is due to a gland other than the thyroid, such as primary pituitary failure exhibiting growth or sex disturbance together with associated determinable signs of thyroid failure. Characteristic chondro-epiphyseal changes are not infrequently seen roentgenologically in a normally con-

stituted, growing child. We believe this is a sign of poor thyroid function which has prevented proper epiphyseal differentiation. Therefore, regardless of the clinical syndrome met with all patients exhibiting such characteristic bone changes should be considered as definitely hypothyroid and treated with desiccated thyroid to bring about normal bone differentiation.

To make our observations more conclusive, we are presenting in this publication twenty-seven patients. All showed chondro-epiphyseal changes associated with clinical symptoms such as pain and impairment of function. The Roentgen diagnoses in this study in all but a few instances were made by a cross-section of able roentgenologists in our area. It can be stated in this regard that in the original study our roentgenological evidence represented more advanced changes than in many of the cases in which specific chondro-epiphyseal changes were diagnosed in this present group. Had we followed these lesser roentgenologic signs in the original study, the percentile incidence would have been greatly increased. Because of the associated local symptomatology plus the unbiased Roentgen diagnoses there can be no doubt that in this group we are dealing with heretofore so-called clinical chondro-epiphysitis. A therapeutic response, shortening of the invalidism, and the return to normal bone detail through adequate thyroid therapy, we believe, is definite clinical evidence of the aforementioned contention.

CASE REPORTS

Perthes' Disease. Case 1. Unilateral. J. W., adiposogenital pituitary type, age five years, was mentally retarded.

In March, 1934, the patient complained of pain in the left hip. The duration was seven weeks. The limp affected the left side. There was normal function of the hip except for restriction to internal rotation. *X*-ray examination revealed "advanced osteochondritis juvenile deformans, left side." (Dr. H. A. Jarre, Grace Hospital.) Basal metabolic rate was minus 35 per cent.

The patient was allowed to be ambulatory with the use of crutches, and he constantly bore weight on his left leg. He was placed under thyroid therapy, and at the end of two months the pain in the hip had disappeared. Follow-up *x*-ray in June, 1938, showed "healed Perthes' disease of the left hip." (Dr. H. A. Jarre.) The Roentgen report of June, 1939, was "osteochondritis juvenilis deformans of the proximal femoral epiphysis, healed; some shortening and broadening of the femoral neck; mild coxa vara." (Dr. H. A. Jarre.)

Clinical examination in August, 1939, revealed normal function of hip and no limp. Duration of thyroid treatment was approximately four years with an average dose of 3½ gr. daily. Basal metabolic rates ranged from minus 35 per cent up to minus 18 per cent, minus 6 per cent, plus 15 per cent and plus 6 per cent.

Case 11. Bilateral. B. P., adiposogenital pituitary type, age five years. In November, 1936, the patient complained of pain in the left hip and thigh. Twenty months previous he fell in the school gymnasium, but recently the pain had increased and the limp had become more noticeable. Examination presented a limp affecting the left side. The left hip revealed normal function except for restriction to internal rotation. The right hip showed normal range of motion and no subjective symptoms. Report of the *x*-ray of the pelvis was "flattening of the epiphyseal portion of the left upper femur indicating an osteochondritis; fragmentation is present; right hip shows similar changes but not so marked." (Dr. C. C. Birkelo, Herman Kiefer Hospital.) Basal metabolic rate was minus 26 per cent.

The patient was ambulatory with the use of crutches and he was allowed to walk as much as he desired. He was placed under thyroid therapy and at the end of two months there was complete disappearance of pain. Follow-up *x*-ray taken in January, 1937, showed "bilateral osteochondritis juvenilis deformans, apparently in the state of repair on the right hip while much more active and in the state of progressive destruction on the left hip." (Dr. H. A. Jarre.) A report in May, 1937, was "bilateral osteochondritis juvenilis deformans of the left hip in the state of repair with some flattening and broadening of the femoral neck; healing identical disease of the right hip; left hip undergoing repair." (Dr. H. A. Jarre.) The

x-ray report, December, 1938, showed "the disease in the right hip essentially healed. The process in the left hip still appears to be in the process of repair." (Dr. H. A. Jarre.) In June, 1939, the *x*-ray report was "osteochondritis deformans juvenilis left hip, in the state of repair, with some flattening of the head and neck." (Dr. H. A. Jarre.)

Fig. 1. Beginning of treatment.

Fig. 2. Final film, five years later.

Fig. 3. Beginning of treatment.

Fig. 4. Twenty-nine months later.

Clinical examination in August, 1939, revealed a normal gait and no evidence of a limp. The right hip had normal functional range. The left hip had slight restriction to internal rotation. The left leg measured 28½ inches and the right, 28⅝ inches. The duration of thyroid treatment was two years and seven months with an average dose of 2½ gr. daily. Basal metabolic rates ranged from plus 15 per cent in April, 1937, to minus 5 per cent in June, 1937, and minus 4 per cent in August, 1939. (Figs. 1, 2, 3 and 4.)

Discussion. Perthes' disease is usually recognized as a condition found in the hip where there is a flattening of the upper femoral epiphysis itself, associated with fragmentation and rarefaction of the epiphyseal head and widening of the neck of the femur. The former orthopedic procedures in Perthes' disease have been bed rest and immobilization with plaster or traction for various periods of time, frequently from one to three years. Operative procedures to hasten recovery and revascularization such as drilling of the upper femoral epiphyses have been advised.[2,3]

It is the writers' contention that with early recognition of juvenile osteochondritis of the hip and adequate thyroid therapy, radical operative procedures and immobilization can be avoided.

Slipped Upper Femoral Epiphyses. Case III. Bilateral old slipped femoral epiphysis., D. Mc., colored, age fourteen years. In May, 1938, the patient complained of pain in the right hip and

about the pelvis. The duration was three years. Examination presented a limp affecting the right side. The hip showed moderate limitation of flexion, good abduction and slight limitation to internal rotation. The left hip presented a good range of flexion, abduction and rotation. Both legs were of equal length.

Fig. 5. Beginning of treatment.

Fig. 6. Sixteen months later.

X-ray report in May, 1938, was: "Bilateral coxa vara, somewhat more marked on the right side than on the left, with mild osseous proliferation from the level of the proximal femoral epiphyses, and the circumference of the right acetabular roof. This deformity we believe to be the result of slipping of the femoral epiphyses. Fusion of the femoral epiphyses is not complete." (Dr. H. A. Jarre.) Basal metabolic rate was minus 14 per cent in May, 1938. *X*-ray taken in May, 1939, showed "bilateral healed slipped femoral epiphyses producing mild coxa vara deformity." (Dr. H. A. Jarre.) *X*-ray in September, 1939, showed "bilateral coxa vara more marked on the right than on the left. The femoral epiphyses are now firmly fused." (Dr. H. A. Jarre.)

No treatment other than thyroid therapy was given. The average dose was 2½ gr. daily. At the end of four months all pain had disappeared. Clinical examination in September, 1940, revealed no definite limp. Flexion of the right hip was present to right angles. There was good range of abduction and slight limitation to internal rotation. *X*-ray taken September, 1940, presented "No material change since the report of September, 1939." (Dr. H. A. Jarre.)

Case iv. J. G., white, age fourteen years, Fröhlich's type. In July, 1940, the patient complained of a limp and pain in the right hip. The duration was two years. He was previously seen by a general surgeon who had applied a plaster cast in the position of abduction to the right hip. Examination following removal of the cast presented an obese boy with a limp affecting the right side. Flexion of the hip was present to right angles. Moderate external rotation of the leg was noted. Limitation of internal rotation was present. Basal metabolic readings ranged from minus 12 per cent in July, 1940, to plus 14 per cent in December, 1940.

In May, 1940, two months previous to orthopedic examination, *x*-ray of the patient was taken in the cast room with the leg in position of abduction. The report was: "A correction of the slipped upper femoral epiphysis was seen in the film study made outside this hospital. Fusion of the epiphysis is not present." (Dr. W. A. Irwin.) The patient was placed on an average dose of 3 gr. of desiccated thyroid daily. No further immobilization was used. He was ambulatory on crutches but bore some weight on his leg. *X*-ray report, August, 1940, showed "a partial slip of the upper epiphysis of the right femur with the diaphysis being displaced slightly anterior and with the metaphysis being widened anteriorly." (Dr. W. A. Irwin.) *X*-ray report, September, 1940, demonstrated "an irregular and notched area in the upper anterior bodies of the vertebrae. This could be considered as a case of epiphysitis of the spine." (Dr. W. A. Irwin.) *X*-ray report, December, 1940, compared with the study made in September, 1940, failed to demonstrate any change in the relationship of the diaphysis and the epiphysis of the right femur. "*Fusion of the epiphyseal line is now present.*" (Dr. W. A. Irwin.)

Clinical examination in December, 1940, presented a child who walked with a right-sided limp. No real external rotation of the leg was present. The right hip showed flexion to right angles. Internal rotation was limited. Abduction was of good range but moderately limited. (Figs. 5 and 6.)

Discussion. Slipped upper femoral epiphyses is a condition in which there is an apparent weak union between the epiphysis itself and the neck of the femur, resulting in a displacement of the head with the neck. It is also spoken of as an ante-version of the neck on the head.[4] Treatment in slipped upper femoral epiphyses has been varied, including radical surgical procedures. This latter still remains an orthopedic measure of definite value. Manual reduction,[5] insertion of a nail,[6] drilling through the epiphyseal plate, and insertion of small grafts[7] have also been recommended, along with immobilization in plaster. While our data on slipped upper femoral epiphyses are still very meager, the writers are of the opinion that with early recognition of slipped upper femoral epiphyses and adequate thyroid therapy, more rapid and more complete fusion of the epiphyseal line may take place, and, therefore, subsequent radical operative procedures may possibly be avoided.

Osgood Schlatter's Disease. Case v. Bilateral, N. L., age thirteen years. In August, 1938, the patient complained of pain in the right knee. The duration was two months. The pain was present when walking or moving the knee. There was no history of injury. The right upper tibia presented a prominent tubercle with definite pain on pressure over this tibial tubercle and patellar tendon. The left upper tibia showed a moderately enlarged tibial tubercle but there was no pain. *X*-ray examination of both knees in the lateral projection revealed "a bilateral irregularity in shape and texture of the tibial tubercle, which we believe to be due to a bilateral Osgood Schlatter's disease." (Dr. A. K. Payne, Grace Hospital Clinic.) Basal metabolic rate was minus 14 per cent.

The patient was placed on thyroid therapy. The average daily dose was 2½ gr. Pain in the knee ceased at the end of three months. Basal metabolic rate in April, 1939, was minus 6 per cent and in August, 1939, it was minus 25 per cent. Thyroid therapy was increased. *X*-ray in June, 1939, revealed "Definite improvement in the Osgood Schlatter's disease." (Dr. H. A. Jarre.) In July, 1939, the report was "healed Osgood Schlatter's, left, but there is still a transverse fissure present through the proximal end of the right tibial tubercle." (Dr. E. M. Shebesta, Grace Hospital.) Final *x*-ray in August, 1939, showed complete healing. (Dr. Jarre.)

Case vi. Bilateral, W. B., structurally normal type, age eleven years. There was delay in academic progress. In March, 1938, the patient complained of having had pain of increasing intensity in both knees for seven weeks. It was aggravated when he participated in sports and when he rode a bicycle. Examination showed bilateral prominent tibial tubercles and bilateral tenderness over the tubercles and patellar tendons. The maximum amount of tenderness was over the tubercles. *X*-ray taken in March, 1938, revealed "Fragmentation of the right tibial tubercle having the characteristic appearance of Osgood Schlatter's disease. More limited changes involving the left tibial tubercle." (Evans and Reynolds.) Basal metabolic rate was minus 7 per cent.

The patient was not immobilized. He was placed under thyroid therapy and after one month the pain in both knees disappeared. Basal metabolic rate was minus 7 per cent in November, 1938, and plus 1 per cent in August, 1939. The average dose of desiccated thyroid was 2½ gr. daily. *X*-ray report in January, 1939, was "Definite reformation of the right tibial tubercle with no fragmentation present. Left knee chiasm between the tubercle and tibial shaft rather wide. There is marked improvement over the condition observed in plates taken in March, 1938." (Dr. Gerald Bernath.) *X*-ray in August, 1939, revealed complete healing in both tibial tubercles. (Dr. Bernath.)

Case vii. Unilateral, J. H., problem child, moderately obese, age twelve years. In February, 1939, the patient complained of pain in the right knee which had been present for five months. The pain increased when walking and running. Examination presented marked tenderness over the right upper tibial tubercle. *X*-ray taken February, 1939, revealed "the right tibial tubercle to be definitely shorter than

on the left; poor radiability; fairly wide chiasm but no fragmentation." (Dr. Gerald Bernath.) Basal metabolic rate was minus 5 per cent.

The patient was not immobilized. Four months following the initiation of thyroid therapy all pain ceased and he was allowed to resume sports, such as hockey. The average dose was 2 gr. daily. Basal metabolic rate in August, 1939, was minus 1 per cent. He did not return for *x*-rays because he had no symptoms.

Case VIII. Unilateral, R. O., adiposogenital pituitary type, age twelve and one-half years. In April, 1937, the patient complained of having had pain in the right knee for one month. The pain was more marked when running and kneeling. Examination presented fullness over the right tibial tubercle with pain on palpation. Weight one year previous was 97 pounds. Weight at the time of examination was 123 pounds. Report of *x*-ray of both knees April 12, 1937, was: "The films reveal an Osgood Schlatter's disease involving the right tibial tubercle with some soft tissue swelling about the tubercle." (Evans and Reynolds.) Basal metabolic rate was minus 15 per cent.

The patient was not immobilized. One month following institution of thyroid therapy pain in the knee disappeared. She received an average dose of 2½ gr. of desiccated thyroid daily from April to October, 1937. Basal metabolic rate in July, 1939, was minus 3 per cent.

X-ray in September, 1937, revealed "definite improvement of the appearance of the tibial tubercle of the right knee." (Evans and Reynolds.) *X*-ray report in July, 1939, stated that there was a normally appearing tibial epiphyseal tubercle. (Dr. Gerald Bernath.)

Case IX. Bilateral, E. L., fairly normal type, age thirteen years. In January, 1939, the patient complained of having had severe pain in the left knee for one year. Recently he had occasional ache in the right knee. Pain was noticed especially when walking or climbing stairs. Examination showed a very prominent tibial tubercle on the left side which was extremely tender to touch. Tenderness was present over both the tibial tubercle and the patellar tendon. The right knee presented no unusual prominence but there was tenderness to palpation. *X*-ray report, January, 1939, of both knees was: "There is considerable fragmentation of left tibial tubercle. It appears to be lifted from the shaft of the tibia proper. Soft tissue swelling present over this region. The right tibial tubercle is moderately lifted, but there is no fragmentation. Summary—Osgood Schlatter's disease, bilateral." (Dr. Gerald Bernath.) Basal metabolic rate was minus 13 per cent.

Due to the severity of pain the left knee was immobilized but only for two weeks. There was a marked decrease in symptoms during the first month of thyroid therapy. At the end of three months all symptoms disappeared. Average dose was 3 gr. daily. Basal metabolic rate in July, 1939, was plus 1 per cent.

X-ray report in May, 1939, was: "Left knee; the fragmented portion of the tibial tubercle has united. There is still some irregularity present. There also appears to be some union of the tongue of the tubercle to the shaft of the tibia. Right knee shows some improvement in the relationship of the tibial tubercle to the shaft. Summary; improving bilateral Osgood Schlatter's disease." (Dr. Gerald Bernath.) *X*-ray report in July, 1939, was "Some further improvement in the left tibial tubercle, but still incomplete reformation. Right knee shows no apparent changes." (Dr. Gerald Bernath.)

Since the early part of June, 1939, four months following the original examination, the patient has been participating in all sports and there has been no recurrence of any symptoms.

Case X. Unilateral, R. S., structurally normal type, age eleven years. In September, 1936, the patient complained of having had pain in the left knee for three months, particularly on bending or kneeling. Examination revealed definite tenderness over the left tibial tubercle. Report of *x*-ray in September, 1936, was "Left knee shows definite lifting of tibial tubercle and broad chiasm between the shaft and tubercle." (Dr. Henry Ulbrich.) Basal metabolic rate was minus 15 per cent.

Two months following institution of thyroid therapy all symptoms disappeared. The average dose was 2 gr. a day. The patient moved to another city and follow-up could not be obtained.

Case XI. Unilateral., O. D., structurally normal type, age twelve years. In April, 1938, the patient complained that for one year she had been having pain in the left knee. Examination presented a prominent left tibial tubercle with tenderness. *X*-ray in April, 1938, showed "Definite chiasm between the tubercle and tibial shaft. No fragmentation." (Dr. H. A. Jarre.) Basal metabolic rate was minus 9 per cent.

Three weeks following initiation of thyroid therapy all pain had disappeared. Average dose was 1½ gr. daily. *X*-ray taken in June, 1939, revealed "No apparent disease at or near the left knee." (Dr. H. A. Jarre.)

Case xii. Unilateral, J. D., hypothyroidism, age fifteen years. In February, 1935, the patient complained of recurrent unaccountable headaches and of having had pain in the left knee for five months. He had fallen from his bicycle and developed what was termed a traumatic synovitis. He had been treated orthopedically with immobilization and rest. The pain was recurrent except when immobilized. Examination revealed slight swelling of the left knee. There was tenderness over the region of the tibial tubercle. *X*-ray examination February 26, 1935, showed lipping of the tubercle plus evulsion such as is seen in Osgood Schlatter's disease. Basal metabolic rate was minus 13 per cent.

The patient was placed on desiccated thyroid in a dosage varying from 1 to 3 gr. daily. After a period of one month no further pain was complained of even though all normal activities were permitted. There was no recurrence of headaches. On May 10, 1935, *x*-ray of the knee still revealed separation of the tubercle but to a much less degree. *X*-ray on October 26, 1935, showed the tubercle of the tibia to be completely fused. Basal metabolic rates ranged from minus 24 per cent to plus 2 per cent.

Case xiii. Bilateral, G. G., hypothyroparathyroidism, age thirteen years. In March, 1937, the patient complained of having had pain in both knees for one month. Examination revealed tenderness over the tibial tubercles. There was no swelling. *X*-ray showed fragmentation of tibial tubercles and irregularity of diaphyses (Osgood Schlatter's disease). Basal metabolic rates were minus 9.6 per cent and minus 16.1 per cent.

The patient received desiccated thyroid in an average daily dose of 2 gr. Following institution of this therapy no further complaint of pain was noted. *X*-ray April 8, 1938, revealed normal osseous structures of the right tubercle; areas of very slight fragmentation in the left tubercle, completely normal bone detail of the diaphyses.

Case xiv. Bilateral, J. S., age twelve years. In December, 1939, the patient complained of having had pain in both knees for three months. Examination revealed prominent bilateral tibial tubercles. Marked tenderness was present over both tibial tubercles. Pain was increased by knee flexion and riding a bicycle. *X*-ray taken

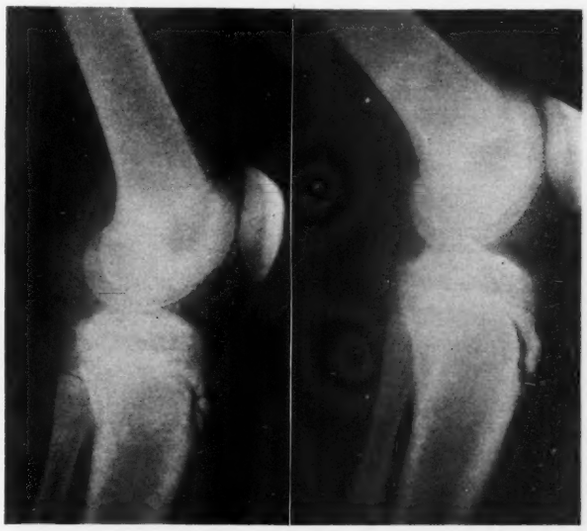

Fig. 7. Beginning of treatment.

Fig. 8. Ten months later.

December 2, 1939, revealed multiple bone centers, that is, fragmentation of both tibial tubercles. No definite bone or soft tissue inflammatory reaction was noted. (Dr. H. L. Ulbrich.) *X*-ray taken February 8, 1940, revealed fragmentations of the epiphyses at the tibial tuberosities with no evidence of any soft tissue swelling or density. (Dr. Ulbrich.) *X*-ray taken September 5, 1940, showed no evidence of soft tissue swelling. The tibial epiphyses were becoming one piece. The different centers were uniting. (Dr. Ulbrich.) *X*-ray taken December 3, 1940, revealed no demonstrable fragmentation of the tubercles or epiphyses. The density and bone detail in both instances were normal. (Dr. Ulbrich.)

The basal metabolic rate was minus 10 per cent. The patient was placed on desiccated thyroid in December, 1939, and the dosage varied from 1 to 4 gr. daily. Two months following institution of thyroid therapy the pain in both knees ceased. The patient has been participating in all activities such as roller skating and ice-skating since the third month of medication. (Figs. 7 and 8.)

Discussion. So-called Osgood Schlatter's disease is probably the most frequent of the chondro-epiphyseal disturbances. The outstanding complaint is pain. The previously recommended orthopedic treat-

ment was that of immobilization in plaster until the pain ceased or until sufficient ossification had taken place. Open operations[7,8] on the tibial tubercle also were advised in order to produce coalescence of fragmentation and to hasten ossification between the tubercle and the shaft.

Immobilization was not employed in nine of the ten patients cited. They were all normally ambulatory. There was no interference with school and play life. The relief from pain was much more prompt than with the older method of immobilization. While the number of patients is not great, we firmly believe that the return of normal bone detail roentgenologically was definitely hastened as compared with the older methods of treatment.

Apophysitis. Case xv. Bilateral, J. E., hypothyroid type, age eight years. In July, 1938, the patient complained of having had pain in both heels and a tendency to limp for the previous eight weeks. The pain had been constant and was increased especially after running. Examination presented a rigid foot limp due apparently to an effort to take the strain off the tendo achilles. Both feet showed normal range of function. All muscles were active and of good strength. There was marked tenderness to palpation over the posterior portion of the right os calcis near the insertion of the tendo achilles. Report of the *x*-ray in July, 1938, was: "Much irregularity and serration of the posterior portion of the right os calcis and a fragmented epiphysis. The left os calcis showed considerable irregularity and rarified epiphysis." (Dr. Ulbrich, Mount Clemens.) *X*-ray in June, 1939, showed "still further improvement in the epiphysis of the left os calcis and marked improvement in the contour of the posterior end of the body of the os calcis. Right showed identical improvement." (Dr. Ulbrich.)

The patient displayed early improvement and six months following the institution of thyroid therapy all symptoms disappeared. Average dose was 3 gr. daily. In June, 1939, the patient walked without any limp. He was very active on the farm where he lived.

Case xvi. Bilateral, D. B., adiposogenital pituitary type, age twelve years. In April, 1939, the patient complained of having had pain in both heels for eight months. The pain was constant when he was on his feet. He was previously hospitalized in one of the large hospitals and placed in plaster. Following discontinuation of this treatment pain again returned and became just as severe as formerly. Examination presented a bilateral limp. The right foot revealed very marked tenderness at the posterior end of the os calcis at and just below the insertion of the tendo achilles. On the left foot there was definite pain at the posterior end of the heel near the insertion of the tendo achilles. *X*-ray report in April, 1939, was: "The epiphysis of the right os calcis is very irregular. Fragmentation is present at the lower end of the epiphysis. There is a small accessory navicular on the left. Diagnosis: Apophysitis of each os calcis more marked on the right; elongated scaphoid on right; accessory scaphoid on the left." (Dr. G. J. Bernath.) Basal metabolic rate was minus 37 per cent.

The patient was not immobilized. Eight weeks after initiation of thyroid therapy all symptoms disappeared. The average dose was 2 gr. daily. Basal metabolic rate in August, 1939, was plus 1 per cent. *X*-ray report in August, 1939, was: "Left, marked improvement in the development of this epiphysis. Serration previously present is not nearly so marked. No fragmentation. Right, the marked irregularity previously present at the posterior end of the os calcis has almost completely disappeared. Fragmentation is greatly improved. There is still one transverse fissure present in lower portion of the epiphysis." (Dr. G. J. Bernath.) The patient at this time presented a normal gait. He was able to run and participate in all games. He was very active at camp.

Case xvii. Bilateral, T. McG., structurally normal type with cryptorchidism, age ten years. In May, 1939, the patient complained of constant pain in the left heel and occasional pain in the right heel. This had been present for three weeks. He could not run. Examination revealed a limp affecting the left side. The left foot showed marked tenderness at the posterior end of the os calcis at and just below the insertion of the tendo achilles. The right heel presented a moderate amount of tenderness at the posterior portion of the os calcis. Studies of both os calces in May, 1939, showed the following: "There is some serration of the apophyses at the posterior portion of each os calcis. The left os calcis shows fragmentation at its lower end. The right os calcis shows what appears to

be beginning fragmentation at its lower end." (Dr. G. J. Bernath.) Basal metabolic rate was minus 23 per cent in May, 1939.

Fig. 9. Beginning of treatment.

Fig. 10. Eighteen months later.

Five weeks after institution of thyroid therapy the patient was completely free of all symptoms and participated in games. Basal metabolic rate in August, 1939, was minus 9 per cent, and on January 9, 1940, it was minus 7 per cent. *X*-ray in August, 1939, revealed "Definite improvement in the body of the epiphysis of the right os calcis. Fragmented area has definite filling in. Left os calcis shows marked disappearance of serration and complete disappearance of the lower fragmented area." (Dr. G. J. Bernath.)

Case xviii. Bilateral, R. S., structurally normal type, age ten years. In June, 1939, the patient complained of having had pain in both heels for one year. Examination revealed a mild bilateral pronation of both feet. The left foot presented definite tenderness to palpation at the posterior portion of the os calcis at and below the insertion of the tendo achilles. The right heel presented tenderness in the same location but not so marked. Studies of both os calces in June, 1939, showed "epiphyseal lines of both os calces are serrated. There are lines of diminished density extending through the left apophysis. Similar, less obvious lines extend through the upper portion of the right apophysis." (Dr. G. J. Bernath.) Basal metabolic rate was minus 8 per cent in June, 1939.

Five weeks following institution of thyroid therapy the heel pain ceased. Average dose was 1½ gr. daily. At this time the patient left on vacation and the medication was stopped. *X*-ray in July, 1939, revealed "Definite improvement in the density of the left os calcis epiphysis. Serration is not so marked as on previous films. Lines of density diminished, show improved density. The epiphysis of the right os calcis shows increased density throughout the entire body of this right epiphysis and less serration." (Dr. G. J. Bernath.) The end of the os calcis still showed some tenderness to palpation. There was no complaint when walking. Thyroid therapy was re-established.

Examination on August 7, 1939, revealed moderate tenderness to palpation. The patient did not complain when walking and running. Duration of observation was two months.

Case xix. Bilateral, J. M., pituitary dwarf, age seven years. In April, 1939, the patient complained of having had pain in both heels for seven weeks. Clinical examination presented some pronation of each foot. There was definite tenderness to palpation at the posterior, lateral and medial aspect of each os calcis. Tenderness was more marked on the left. *X*-ray in April, 1939, showed "marked fragmentation of the apophyses of each os calcis. Epiphyseal line is serrated and irregular. The changes are those of an apophysitis." (Dr. G. J. Bernath.) Basal metabolic rate was minus 16 per cent.

Following five weeks of thyroid therapy all subjective signs subsided. The average dose was 1½ gr. per day from April to June. He did not return for follow-up for several weeks. In July, 1939, he presented no subjective symptoms, but there was definite tenderness to palpation of the epiphysis of each os calcis. *X*-ray report was "each os calcis still shows fragmentation of each epiphysis." (Dr. G. J. Bernath.) The patient still requires thyroid therapy.

Case xx. Bilateral, W. H., adiposogenital pituitarism, age twelve years. On August 22, 1939, the patient's chief complaints were pain in both heels, genital hypoplasia and obesity. Since attending gymnasium class for the previous three years he had complained frequently of pain in both heels. It had been worse, however, for the preceding few months when he walked or bore his weight for any length of time. He was forty pounds above the maximal normal and his height was at the upper limit of normal. The penis was about the size of a five year old child. While the testicles were descended into the scrotum, they were soft in consistency and definitely hypoplastic. There was tenderness over both heels. *X*-rays of the elbow and ankles presented a chondro-epiphyseal disturbance in the trochlea and evidence of fragmentation of both os calces. Changes were more marked in the left heel. Basal metabolic rate was minus 4 per cent. Blood cholesterol was 210 mg. per 100 cc. blood.

Fig. 11. Beginning of treatment.

Fig. 12. Eighteen months later.

The patient was placed on desiccated thyroid, gr. 3 daily, and the anterior pituitary sex-like hormone, 3 cc. twice weekly. The pain in the heels definitely subsided one month after institution of treatment and he was allowed to play football. The genital hypoplasia and obesity were corrected. There has been no further complaint. Follow-up *x*-rays were not obtained as the mother deemed the patient quite well when seen one year later. (Figs. 9, 10, 11 and 12.)

Discussion. Epiphyseal disturbance of the os calcis, like Osgood Schlatter's disease, is very common. With or without treatment the ultimate prognosis is usually good. The pain, however, is a frequent cause for immobilization and loss of school and play time. In the six patients cited no immobilization was deemed necessary. The outstanding symptom, pain, was much more rapidly relieved by desiccated thyroid than by the older methods,[10,11] and the return to normal bone detail roentgenologically was much faster.

Köhler's Disease. Case xxi. P. G., generalized chondro-epiphyseal disturbance, pituitary dwarf, secondary hypothyroidism, age eleven years. The patient was first seen January 18, 1932. His chief complaint was lack of statural growth. His standing height was 5.8 inches below the minimal normal. All other measurements were comparatively below the minimal normal, conforming with the diagnosis of true pituitary dwarfism. In addition he presented clinical signs of secondary hypothyroidism: alabaster type of pallor, dry skin, and a relative bradycardia. Secondary anemia was evidenced by a red blood cell count of 3,500,000. Basal metabolic rates were minus 29 and minus 30 per cent. *X*-rays taken January 23, 1932, of the knee, elbow, wrist, shoulder, hip and ankle gave a bone age delay of fully three to four years. All developing osseous centers revealed chondro-epiphyseal changes. The ankle displayed marked Roentgen signs of Köhler's disease. Dr. Lewis Clark Wagner, New York, was called in consultation, and he confirmed

the above Roentgen findings plus a marked degree of flat foot for which he recommended orthopedic shoes. It was his opinion that the generalized chondro-epiphyseal disturbance was endocrine in origin. These films were also reviewed at that time by the roentgenologists at the Ruptured and Crippled Hospital, New York, who concurred in general with the above findings.

The following treatment was administered: desiccated thyroid in a tolerant dose varying from 2 to 4 gr. daily; injections of the growth hormone in the form of antuitrin-G, 2 to 5 cc. twice weekly. Check-up films of the same joint regions taken April 11, 1932, revealed no marked change in the chondro-epiphysitis present. There was, however, a definite advance in the osseous development. *X*-rays taken January 24, 1933, and August 2, 1933, showed definite improvement of the chondro-epiphyseal disturbance. *X*-rays of April 10, 1934, displayed almost complete healing of what was previously termed Köhler's disease. There was marked improvement in both osseous development and the pathological changes first noted. Treatment and observation were continued until March, 1937, at which time the *x*-rays revealed normal osseous development and normal bone detail. His height was 63.2 inches which was 2 inches above the minimal normal. Adolescence was then occurring normally together with epiphyseal closure. Treatment was withdrawn. At the present time he is an average sized young man and sex development has been normally completed.

Case xxii. R. M., hypothyroidism, age five years five months. The patient was first seen January 11, 1940. His chief complaints were obesity, physical sluggishness, marked flat foot and difficulty in running. His weight was ten pounds above the maximal normal and his height was just below the maximal. Basal metabolic rates were not obtained. The diagnosis of hypothyroidism was based on the clinical findings of his generalized obesity, physical inactivity, dry skin with subcutaneous thickening and suggestive hypothyroid pallor. *X*-rays of the wrist, elbow, knees, ankles and hip displayed a delay in osseous development of slightly over one year. Chondro-epiphyseal changes were noted in both ankles. The scaphoid, both internal cuneiforms and the heads of both second metatarsals exhibited marked irregularity in osseous detail. They were moth-eaten and ragged in appearance. The heads of the third metatarsals exhibited the same change but to a less degree. There were suggestive changes in the left scaphoid. The Roentgen diagnosis was bilateral Köhler's disease.

Fig. 13. Left, beginning of treatment; right, fifteen months later.

A proper orthopedic shoe was prescribed for the patient. Desiccated thyroid was given in a tolerant dose varying from 3 to 4 gr. daily. Comparative films of both ankles taken May 14, 1940, showed improvement of the so-called Köhler's disease, but the changes were still definite. *X*-ray of both ankles made September 20, 1940, revealed that the former evidence of Köhler's disease had almost entirely cleared. There was still some slight irregularity of the third and fourth metatarsals, but the rest of the osseous structures showed normal roentgenographic bone detail. (Fig. 13.)

Discussion. Two cases of Köhler's disease are described because of the advanced Roentgen picture and disturbance of gait. Both presented bilateral involvement. It is most probable that more radical treatment would have been given had these patients sought usual orthopedic care. In the first case presented there was complete return to normal bone detail roentgenologically with thyroid therapy. The second is still under treatment but according to the *x*-rays he, too, is approximating normal bone detail.

Former orthopedic procedures include immobilization[12,13] with occasional indication for arthrodesis, osteotomy and excision of the involved heads of the bones even including excision of the related metatarsal

and phalanx. Despite this heroic treatment results were not always satisfactory.

Epiphysitis of the Spine. Case xxiii. W. W., slipped upper femoral epiphysis, left, adiposogenital pituitary type, age fifteen years. In April, 1939, the patient complained of having had pain in the left hip for six months. He had poor posture. There was no history of injury. Examination revealed a rather definitely obese individual walking with a left limp, the left leg being in marked external rotation. The spine showed a marked round back and increased lordosis. The abdomen was prominent. Slight left dorsal scoliosis was present. There was bilateral genu-valgus and bilateral pronated feet. Left hip had flexion to right angles and presented limited abduction and total loss of internal rotation. *X*-ray in April, 1939, revealed "Downward slipping and rotation of the femoral head of the left hip. Right hip negative. There is slight tilting of the pelvis, the left side being higher than the right. Diagnosis: slipped femoral epiphysis." (Dr. G. J. Bernath.) *X*-ray of the dorsal lumbar spine displayed: "Moderate scoliosis, convexity to the left, apex being at the eleventh to twelfth dorsal vertebra. In the lateral view is noted an irregularity of the epiphyses of all the dorsal vertebrae. There is irregularity of the articulating portions of these vertebrae. Summary of the spine *x*-ray: multiple epiphysitis." (Dr. Bernath.) Basal metabolic rate was minus 3 per cent.

The patient received desiccated thyroid in an average daily dose of 3 gr. *X*-ray in August, 1939, was reported as follows: "Dorsolumbar spine shows very little if any change since the last examination in April, 1939. *X*-ray of the pelvis taken the same date shows progressive slipping of the upper femoral epiphysis, left." (Dr. Bernath.)

Aching and fatigue in the spine disappeared two months following institution of thyroid therapy and postural exercises. The slipped femoral epiphysis was progressive. Examination of the left hip in August showed marked restriction of flexion, abduction and rotation. The leg was still in a position of marked external rotation. Replacement of epiphysis with nailing was performed September, 1939. Report of the *x*-ray of the spine December 14, 1940, was as follows: "Lateral views of the dorsal lumbar spine still show evidence of epiphysitis involving all but the first four dorsal vertebrae and also involving the upper borders of the first two lumbar vertebrae. No further wedging of the dorsal vertebrae is noted." (Dr. E. M. Shebesta.)

Clinical examination in December, 1940, revealed that the posture of the individual had shown definite improvement. There had been no recurrence of aching or fatigue in the back. There was no increase in the spine curve. Left hip presented flexion restricted to slightly below right angles. There was no exterior rotation. Interior rotation was limited.

Case xxiv. L. S., adiposogenital pituitary type, age thirteen years. In April, 1938, the patient complained of pain in the lumbar spine. He gave a history of slipping on some steps one month previous while in Arizona. Following this mild injury he complained of pain in the lower back. He was seen by an orthopedist who *x*-rayed his spine. A diagnosis of a fracture of the third lumbar vertebra was made, and the patient was placed in a plaster jacket with the spine in some hyperextension. Clinical examination revealed an obese boy with genital hypoplasia. *X*-ray forwarded from Arizona showed what appeared to be an irregular indentation of the upper anterior portion of the third lumbar vertebra. No definite compression was noted. Further study of these same films revealed some irregularity and small raised bodies about the upper lumbar and lower dorsal vertebrae. Because of the peculiar findings it was believed that this lesion might not be a fracture but part of a generalized epiphysitis of the spine. Tuberculosis was eliminated. He remained in his plaster jacket until May, 1938, and *x*-rays revealed absolutely no change in either the third lumbar vertebra or in the upper lumbar or lower dorsal spine. A diagnosis of multiple epiphysitis of the spine was made. In June an endocrine survey revealed a basal metabolic rate of minus 28 per cent.

The patient received desiccated thyroid in an average daily dose of 4 gr. The plaster jacket was discarded and no further support was used. All signs of backache disappeared even under normal activity. Follow-up basal metabolic rates were minus 17 per cent in December, 1938; minus 19 per cent January 9, 1939; minus 20 per cent January 14, 1939; and minus 15.2 per cent August 29, 1939.

Report of *x*-ray in July, 1938, was as follows: "The moth-eaten irregularity seen in the anterior portion of the third lumbar vertebra is

still apparent. However, there seems to be some improvement in the calcium deposition in this area. The zone of decalcification seems to be filling in. We also note irregularities about the site of the epiphyseal plates of the other lumbar vertebrae. These findings were not so clearly noted on previous examination. On the basis of this observation we are now inclined to believe that the pathology presents an epiphysitis." (Dr. G. J. Bernath.) *X*-ray taken October, 1938, showed "Slight improvement in the appearance of this condition." (Dr. Bernath.) *X*-ray in December, 1938, displayed "This condition appears to be the same as the last *x*-ray examination." (Dr. Bernath.) Report of *x*-ray in March, 1939, was: "There appears to have been some additional filling in through the upper anterior portion of the third lumbar vertebra. The vertebra is maintaining its normal shape and there is no evidence of wedging." (Dr. Bernath.) Report of *x*-ray in June, 1939, was: "The changes previously described in the upper anterior portion of the third lumbar vertebra shows marked improvement. There appears to be excellent filling-in in the upper anterior portion of this third lumbar vertebra. Summary: *x*-ray study shows definite improvement in filling-in of this moth-eaten irregular appearing area."

Follow-up report in August, 1939, revealed that there had been no pain in the lower back following the removal of the jacket and establishment of thyroid therapy. Activity in all games did not produce pain. Function of the back was normal. Obesity was reduced. The genital hypoplasia was corrected.

X-ray in October, 1940, of the dorsolumbar spine showed the vertebral epiphyses to be well healed. (Dr. Shebesta.)

Case xxv. F. L. Immature type, age fourteen years. In March, 1939, the patient complained of poor posture of the spine and generalized aching in the back. Clinical examination presented left dorsolumbar, right lumbar curve with slight rotation. Report of *x*-ray in March, 1939, was as follows: "The anterior-posterior view showed slight curvature of the spine involving the dorsal and lumbar region. No marked rotation. Partial spina bifida from the twelfth dorsal to the fifth lumbar. Lateral view showed irregular punched-out areas of the upper anterior portions of the bodies of the third, second, and first lumbar vertebrae and twelfth, eleventh, and tenth dorsal vertebrae." (Dr. Ulbrich, Mount Clemens.) Basal metabolic rate was minus 4 per cent.

The patient received an average daily dose of 2 gr. of desiccated thyroid and was given postural exercises. At the end of two months he did not complain of pain in the back. He avoided treatment for a period of three months, and in August, 1939, his basal metabolic rate was minus 20 per cent. Thyroid therapy was re-instituted beginning with 1½ gr. per day. Report of *x*-ray taken in August, 1939, was the following: "Anteroposterior view of the spine shows a definite improvement over the films taken in March, 1939. The alignment of the dorso-lumbar spine is practically normal. However, there is still some irregularity over the upper anterior portion of the bodies of the upper lumbar and lower dorsal vertebrae. We believe that these epiphyseal changes in the spine are the cause of progressive scoliosis and are of endocrine origin." (Dr. Ulbrich.)

Case xxvi. V. M., underweight, age seven years. In April, 1932, the patient complained of curvature of the spine. Examination showed a left dorsal, right dorsal lumbar curvature with rotation. *X*-ray showed a rather marked scoliosis in the dorsal and lumbar region, apex of the dorsal curve being in the mid dorsal region. There was some wedging of the bodies of the dorsal vertebrae. The patient was treated with suspension jackets, frame treatment with head, lateral and pelvic traction. Good correction of spinal deformity was obtained. The spine was then fused. Following the removal of plaster subsequent to spine fusion and application of brace, it was noticed that the deformity still was progressive. This may have been due to lack of complete fusion. She was not seen then for a period of months. Examination in 1935 showed a marked increase in the dorsolumbar curve with marked increase in rotation. Basal metabolic rate was minus 35 per cent.

The patient was placed on thyroid therapy, believing that the progressive scoliosis plus the low metabolic rate was due to hypothyroidism. The average dose was 3 gr. daily. Basal metabolic rate was minus 5 per cent in December, 1938, minus 4 per cent in May, 1939, and minus 2 per cent in August, 1939. Follow-up *x*-rays at various intervals showed increasing deformity of the spine. However, since raising the basal metabolic rate and continuing the thyroid therapy, the deformity seemingly has remained fixed.

Examination in March, 1940, presented a left dorsal, right dorsolumbar curve but no further increase in deformity. The vertebrae in both the dorsal and lumbar regions seemed well fixed.

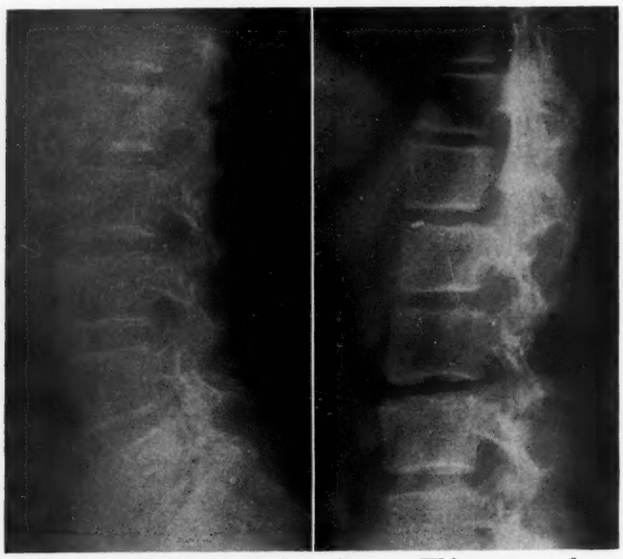

Fig. 14. Beginning of treatment.

Fig. 15. Thirteen months later.

Fig. 16. Beginning of treatment.

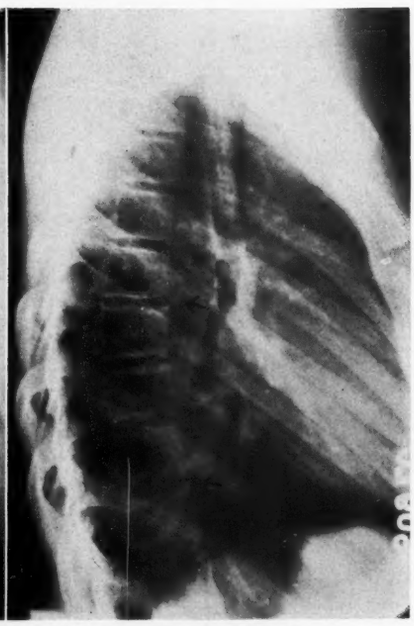

Fig. 17. Five months later.

Case xxvii. B. C., age twelve years. In June, 1939, the patient complained of a prominent right hip and fatigue in the back. Examination in the upright position revealed a mild, left dorsoright lumbar curve with slight rotation. There was no muscle weakness. *X*-ray in June, 1939, in the prone position showed the spine to be fairly straight. "Small triangular epiphyseal ossifications are present about the anterior corners of the lower dorsal vertebrae. Several of the vertebrae show irregularities about the epiphyseal line. The seventh and eighth dorsal vertebrae show some tendency to wedge. Summary: the findings are those of an early epiphysitis." (Dr. G. J. Bernath.) Basal metabolic readings in June, 1939, were minus 11, minus 17 and minus 13 per cent.

The patient was placed under thyroid therapy in an average dose of 2½ to 3 gr. daily and given postural exercises for the back. At the end of two months all fatigue in the back had dis-

appeared. The moderate spinal curve was not increased.

X-ray report in July, 1940, was as follows: "Epiphyseal irregularities previously observed are still apparent. They appear to be in closer contact with the vertebral bodies at this time. There is a slight convexity of the lumbar spine." (Dr. G. J. Bernath.) *X*-ray report in December, 1940, showed "epiphysitis of the seventh dorsal vertebra and apparently to a slight extent of the eighth and ninth as well. No appreciable deformity is present." (Dr. E. M. Shebesta.)

Clinical examination of the spine in December, 1940, in the upright position showed the contour of the spine to be fairly straight. There was no increase in the curve. All fatigue had ceased. (Figs. 14, 15, 16 and 17.)

Discussion. It is possible for many of the so-called idiopathic scoliotics to be prevented entirely or the aggravation of an existent curvature to be ameliorated if early diagnosis is made and treatment with desiccated thyroid instituted at its recognition. Corrective orthopedic measures[14,15] must be employed when gross deformity is demonstrated either physically or by Roentgen ray. The changes seen in the vertebrae roentgenologically are similar to those revealed in the other so-called clinical entities. It will be most gratifying if the future proves this to be true and the incidence of this deforming condition is lessened because the other conditions do not ordinarily lead to such grave future consequences to the patient. Routine Roentgen studies should be made, therefore, in all pre-adolescents displaying postural vertebral changes. If this area were routinely included with the roentgenographic study for osseous development by all clinicians interested in endocrine medicine, we believe it would be excellent prophylactic means to obviate the development of so-called idiopathic scoliosis.

SUMMARY

A consecutive group of twenty-seven cases of juvenile osteochondritis is presented. Of the twenty-seven patients two males were classified as Perthes' disease; one male and one female as slipped upper femoral epiphyses, seven males and three females as Osgood Schlatter's disease, 5 males and 1 female as apophysitis, two males as Köhler's disease and three males and two females as epiphysitis of the spine. The age range was from five to fifteen years. All displayed definitely related symptomatology. The Roentgen diagnoses in all were unbiased as they were made by a cross-section of able roentgenologists. Every patient routinely received desiccated thyroid orally in a full, therapeutic dose. In addition, those patients displaying other signs of endocrine dysfunction, such as the late descent of testicles and delay in adolescence, were treated with the pituitary sex-like hormone. An attempt was made to correct obesity when present. All cases were ambulatory. No immobilization was necessary except for Case IX under Osgood Schlatter's disease whose knee was immobilized for only two weeks. No hospitalization was required. The expense was reduced to a minimum. Normal ossification of the epiphyses was hastened as indicated from the subsequent *x*-ray findings. Clinical cure was affected more rapidly.

It is our belief that the pre-accepted orthopedic methods of treatment are fundamentally incorrect and present many disadvantages. The period of immobilization is long. It can lead to restriction of joint function, muscular atrophy and loss of school and play time. The expense of hospitalization and convalescent care may rise to considerable proportions. Open operations requiring even more detailed care have not produced the desired result either etiologically or functionally because the lacking tissue differentiating factor is not supplied. While immobilization can and does relieve pain, there is no stimulation of the true etiological factor involved without thyroid therapy.

CONCLUSIONS

Chondro-epiphysitis or juvenile osteochondritis is a misnomer. The characteristic

epiphyseal picture is due to hypothyroidism and a consequent lack of the thyroid tissue differentiating factor. "Osteochondreal hypothyroidism" is a term suggested because we believe these changes are pathognomonic of hypothyroidism in the same manner as a definite retardation in osseous development. Basic treatment, therefore, is adequate thyroid therapy. Orthopedic procedures are secondary or adjunctive.

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From the pathologic point of view the bosselated type of goiter is distinctive because organic changes are expressed in terms of acinal hyperplasia and only incidentally in epithelial hyperplasia. This is the important point, not the fact that they have bosselations.

BONE DRILLING IN RESISTANT CHRONIC ULCERS

A NEW PRINCIPLE

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OF all types of ulcers, this communication will deal only with those that never produce any real, satisfactory granulations on the ulcer bed, but continue after long periods of time to have a dirty grey or yellow glistening base. The more resistant of these are those that develop excessively thick, dense peripheral scars, the removal of which carries one down to bone. They are still more resistant to repair if the lesion has edema in the periphery of the ulcer base.

There are many of these cases situated on the leg which receive conservative treatment for months or years with little, if any, benefit. They not only fail to respond to treatment, but increase in size and extent until the patient may be reduced to invalidism.

In such cases, the potentiality to heal is practically lost. The nature of the original infection may be such as to prevent, positively, the initiation of processes which lead to healing. The original specific infection may be known, as in tuberculous ulcer, or unknown.

All such cases have been heretofore very resistant to the surgeon's efforts, or to other treatment over long periods of time. While the tissues in and about the ulcer are making strenuous attempts to destroy the injurious agent, changes in the vessel wall and the connective tissues about them may become so extensive that even when the primary causative factor has been entirely removed, healing cannot take place.

In cases of this type the walls of the vessels may gradually thicken until they become incapable of supplying nutrition to the healing process. As this continues the blood vessels may become almost entirely obliterated. The unfavorable conditions brought about by the local changes in the blood vessels just enumerated may be still further complicated by other factors, especially changes in the nearby circulation, as is so frequently observed in varicose ulcers. In this instance the stasis of the general surrounding venous circulation may produce such a stagnation that healing is entirely prevented.

The relation of blood vessel walls and connective tissue varies. In the slowly developing granulations, connective tissue existing between the blood vessels may predominate and the final result may be the formation of fibrotic nodules. In this way, the ulcer becomes completely surrounded by a keloid-like border. Blood vessel walls become so thick that their lumina are practically obliterated, the ulcer becomes permanent because all nutriment is shut off and healing will not commence until a new blood supply is established which, without appropriate surgical intervention, is impossible.

These conditions are particularly well illustrated in the type of ulcers reported in this communication. In such cases, when the base of the ulcer is attached to underlying bone, it is obviously necessary to provide a new bed, if healing is to take place or skin grafting is contemplated.

In the past, the profession in general has recognized this need of establishing new circulation and to accomplish this has resorted to excision of the entire border of the ulcer or has made numerous cross incisions through the base of the ulcer and well into the surrounding soft parts, thus hoping to stimulate blood vessels to reach the base of the ulcer from surrounding tissues

The ulcer may finally heal, after such operative work and many months of

strenuous treatment, including retention of patient with elevation of limb in bed, but the resultant covering epithelium is likely to be irregular and the corium poorly developed with underlying dense fibrous tissue with thick blood vessel walls and a varying amount of cellular infiltration. Healing of this character is imperfect and if there is ever the slightest traumatism or unfavorable circulatory condition the new formation of skin is likely to break down again and the ulcer recur.

These unfavorable conditions are much more likely to result where the blood supply to the ulcerated skin is cut off by lying close upon bony tissue. Ulcers situated in regions where the bone is superficial are notoriously resistant to all types of treatment heretofore applied. This is particularly true of the lower portion of the tibia where there is added the unfavorable influence of dependency.

It has been accepted by all that a disturbance in circulation is a common factor in both the causation and the persistence of ulcers. One of the most frequent examples of this is the venous congestion of the lower leg associated with varicose ulcers. This is undoubtedly the chief causative factor. There is an associated edema due to the imperfectly aerated blood in contact with blood vessel walls making this more readily penetrable to serum. The capillary circulation is influenced and lack of nutrition to the tissues follows. The ultimate result is a failure to produce healthy granulation tissue. The arterial walls may undergo hyaline degeneration which may finally result in obliterative endarteritis. The result is a granulation tissue, the blood vessels of which have thick, fibrous walls not capable of providing nutrition for a healthy healing process.

To quote Dr. Arthur E. Hertzler, "This vascular embarrassment is apt to be more pronounced in areas in which the tissue is sparse of vessels as that over the tibial crest, and for the same reason the associated infection is more apt to be intensive and add its burden to the healing process. While the foregoing remarks apply to the ubiquitous varicose ulcers of the leg they may become the dominant factor even in the specific ulcer, particularly tuberculosis and blastomycosis after the disease has existed for a long time."

A perusal of the literature will convince any one that the surgical methods used to overcome such outstanding vascular inadequacy have not been sufficient. They have consisted, in brief, of rimming the ulcer of its indurated border with scalpel, curetting the base of the ulcer or radical incisions through the ulcer extending into its surrounding soft parts, the hope being that in time blood vessels will be stimulated to reach the desired center of the ulcer which is essential to new healthy granulations.

As has been the case too frequently, particularly in bone graft surgery, the surgeon has not paid sufficient attention to biophysiology or anatomy and has not realized that of all the blood supply coming to bone 75 per cent of it comes via the interior or the marrow of the bone, whereas only 25 per cent of it comes via the periphery or periosteum.

With these facts established, there would seem to be no chance for argument that if it is possible to tap the rich reservoir of blood under the ulcer base, in the center of the bone, this, above all others, is the objective for which to strive.

If *a priori* reasoning has ever come through, it has in this instance, because when the bone cortex beneath the ulcer base has been drilled sufficiently to the center of the bone, to allow blood to well up there has always been an unusually prompt appearance of healthy granulations and healing of the ulcer as demonstrated by the nineteen cases herein reported.

This has been found true in ulcers due to trauma, osteomyelitis, inadequate blood supply, due to local changes and to varicosities; phlebitis; neurogenic or trophic disturbances, deficiency in nutrition and ergot poisoning.

The surgical technic of such procedure is extremely simple. The leg is prepared as

it would be for any aseptic operation, shaved, any dead skin around the periphery and ulcer carefully removed and tincture of iodine preparation completed. At operation, an excess of tincture of iodine 3½ per cent is applied. As a last preparatory step, the ulcer is filled with 3½ per cent tincture of iodine. The indurated border of the ulcer is removed by a small, sharp scalpel. The base of the ulcer is thoroughly curetted and an additional coating of tincture of iodine is applied. With a small motor drill (⅛ inch in diameter) multiple drill holes are made through the underlying bone cortex sufficiently deep that blood wells up. This is always the criterion. The ooze soon stops from pressure of a gauze pad directly over the ulcer. The wound is then dressed with a gauze dressing saturated with paraffin 90 per cent, vaseline 10 per cent, and in order to produce complete immobilization of the part when the ulcer is near a joint and fixation is desirable, a plaster of Paris cast is applied to the limb. If the lower part of the tibia is involved, the plaster is extended from the toes to the tubercle of the tibia. The patient is then returned to bed with instructions that the operated leg be elevated to a degree of three pillows. The plaster of Paris cast is left on for a period of one week. Following this, frequent dressings are done, using either vaseline gauze according to Orr, or paraffin compound gauze.

The profuse blood supply thus brought to the ulcer has achieved healing in over two-thirds of all patients operated upon. In the remaining one-third of these cases, the treatment resulted in a granulation bed very favorable to skin grafts and because of the size of the ulcer more rapid healing has been effected by their application. Skin grafts have taken most satisfactorily upon the favorable granulation bed thus afforded. In no instance has there been deep infection from the drilling through the base of an ulcer. This, I believe, may be partly due to immersing of the drill in and the puddling of the ulcer base with tincture of iodine at the time the drill is thrust into the bone, and partly due to the care always to drill deep enough to tap the blood supply so that it profusely wells from the drill hole precisely as one milks blood from a hole in his finger when it has been pricked.

Case No.	Duration of Ulcer before Drilling	Site of Ulcer	Cause of Ulcer	Skin Graft	Length of Time between Drilling and Healing
1	9 mos.	Metatarsal	Trauma	No	17 days
2	8 mos.	Tibia	Osteomyelitis (compound)	Yes	3 mos.
3	15 yrs.	Tibia	Osteomyelitis	Yes	5 mos.
4	1 yr.	Tibia	Osteomyelitis (comp. fracture)	No	5 mos.
5	6 yrs.	Tibia	Osteomyelitis	No	7 wks.
6	5 yrs.	Fibula	Varicose ulcer (phlebitis)	No	7 wks.
7	6 mos.	Tibia	Varicose ulcer	No	3 mos.
8	1½ yrs.	Fibula	Trauma (fracture)	No	7 wks.
9	9 mos.	Tibia	Poliomyelitis (neurogenic or trophic disturbance)	No	9 wks.
10	5 yrs.	Tibia	Trauma	No	6 wks.
11	2½ yrs.	Tibia	Osteomyelitis (compound fracture)	Yes	3 mos.
12	15 yrs.	Tibia	Ergot poisoning	Yes	2 mos.
13	3 yrs.	Tibia	Trauma (fracture)	No	4 mos.
14	1½ yrs.	Os calcis	Trauma (fracture)	No	2 mos.
15	1½ yrs.	Femur	Trauma	Yes	5 mos.
16	14 yrs.	Tibia	Osteomyelitis	No	6 wks.
17	13 yrs.	Tibia	Trauma	Yes	2 mos.
18	1 yr.	Tibia	Osteomyelitis	No	2 mos.
19	3 mos.	Tibia	Osteomyelitis	No	7 wks.

Summary of Nineteen Cases of Resistant Chronic Ulcers

Cause of Ulcer	No. of Cases
Trauma	7
Osteomyelitis	5
Osteomyelitis (following compound fracture)	3
Poliomyelitis (trophic disturbance)	1
Varicose ulcer	1
Varicose ulcer (phlebitis)	1
Ergot poisoning	1
Site of Ulcer	**No. of Cases**
Metatarsal	1
Os calsis	1
Femur	1
Fibula	2
Tibia	14

Average duration of ulcer..... 4 years and 8 months
Average length of healing time.. 9½ weeks

SUMMARY

The unusually satisfactory results enumerated in detail in this communication are of particular gratification and interest

to me in that they illustrate the dependability of the principles of both physiology and biology when applied to surgical procedure.

The plan of the above treatment was arrived at by me from extensive experience in reconstructive surgery where at the operating table over a period of thirty-five years, I have repeatedly proved that the essential requirement of all reconstructive work is to make way for the provision of an adequate blood supply. I have often made the statement that new bone formation is no more likely to occur than a masonry wall without brick and mortar with which to build it, no matter how skillful the mason may be. It was my theoretical deduction that if we could bring an adequate blood supply from the center of the bone, through the cortex, directly to the base of the ulcer, by every physiological and biological principle the ulcer should promptly heal. This has been proved as definitely as it has been proved that when an adequate blood supply is brought to a bone graft, it will survive and thrive.

DIFFUSE toxic goiter is as distinctive in the clinic as in the laboratory. It is characterized by vascular changes and a hard uniform gland. The patients show tremor, a rapid heart rate, and extreme loss in weight. In some there are eye signs; these are the true cases of Basedow's disease. The tendency is to run an acute course and to enter a remission after a period of months or years.

THE DIFFERENTIAL DIAGNOSIS OF THE "PAINFUL HIP" IN CHILDHOOD

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THIS title is chosen in order that the differential diagnosis of such a vague term as "painful hip" may be reviewed. The term is not to be regarded as a diagnosis in any way but merely as a symptom. Formerly all children with the complaint of pain in the hip were rather loosely diagnosed as "tuberculosis of the hip," but with more thorough history taking and examining acumen, aided by roentgenograms and laboratory data, other conditions have been revealed and we should like to review some of them.

For convenience of discussion we have divided the patients with complaint of pain in the hip into three general groups: those of inflammatory origin, those of traumatic origin and the epiphyseal disturbances.

I. INFLAMMATORY

A large majority of hip affections in children are tuberculous, though tuberculosis of the bones and joints has undoubtedly decreased in the past twenty-five years. This disease was originally seen in poorly nourished children; although today when cases are seen earlier, the condition is frequently encountered in robust looking individuals. Tuberculosis of the hip joint has been classified under many names: hip joint disease, morbus coxae, quiet hip, hip disease, etc. The condition is essentially one of early childhood and the disease usually first appears in the bone near the metaphysis, while its chief manifestations are evidenced within the joint proper. In 5,000 cases of tuberculous disease, seven-eighths of the patients were less than fourteen years of age, and about 75 per cent were in the first decade of life. The disease is rare before the age of two, most of the cases occurring between the ages of three to ten years.

Very early recognition of the disease may be quite difficult. The hip joint is guarded and protected by the muscles surrounding it and to those sentinels of Nature we must look for early clinical evidence of the disease. Tuberculosis of the hip is not primarily painful. The child does not frequently complain of pain during the waking hours in the very early stages, but the so-called "night cries" are common and are often noted even though the patient makes no complaint of pain during his periods of activity. These night cries are produced by sudden movements of the joint while the patient is asleep and the muscles relaxed. A sharp spasm or contraction of muscles ensue when the inflamed or diseased joint surfaces rub together.

A careful and gentle physical examination in the early stage may disclose only muscle spasm of the adductor muscles. Next to this early muscle spasm the limp is the most important and constant sign of the disease, and it is a *constant finding*. The patient should always be stripped and placed in a good light while being examined and measured. Sometimes requesting the patient to run across the room may be the means of disclosing early an otherwise hidden limp, and a little later the characteristic clinical signs of limitation of motion in all directions, muscle atrophy and persistent flexion of the hip may be found. While the limb is initially held in slight abduction and outward rotation, the joint irritation will soon permit the strong adductor muscles to pull the hip into adduction and the limb will appear shorter than its opposite fellow. (Fig. 1.) For this reason, the lower

extremities should always be measured in the line of deformity and with the pelvis level, in order to get the true shortening.

FIG. 1. Roentgenogram showing characteristic appearance of tuberculosis of the right hip joint, showing bone destruction of both head and acetabulum. Hip has been pulled into the characteristic attitude of a flexion and adduction deformity.

In summary, therefore, a chronic, monarticular disease in early childhood, accompanied by limp, muscle spasm, muscle atrophy and limitation of motion in all directions, with or without the history of known injury, is quite suggestive of tuberculosis. In the early case the roentgenograms are of little value in determining the diagnosis, but are of inestimable value in disclosing a nontuberculous lesion. Soon after, the bone atrophy, with the blurred appearance of the joint in the roentgenogram and evidence of bone destruction, may be of great aid in confirming the physical signs of tuberculosis. The tuberculin test is a very valuable test for young children. Also, aspiration of the abscess and its injection into a guinea pig may be useful in proving the suspected diagnosis. In a suspected case of tuberculosis when other data prove negative, a biopsy from the affected joint tissue may be taken.

Bursitis. There are various bursae about the hip joint and one or more of these through injury or inflammation may become swollen. The greater trochanter region is frequently the site of bursal or osseous pathology and it may be tuberculous in origin. One should always be suspicious of tuberculosis when there is inflammation of the bursa situated in the region of the greater trochanter. The limp and pain on certain movements of the hip joint that place strain on the bursal tissue, accompanied by local swelling of the bursa, are characteristic findings in bursitis. One may see an iliopectineal or iliopsoas bursitis with accompanying muscle spasm and general limitation in joint movement, though this bursal inflammation is rarely tuberculous.

Lumbar Pott's Disease. Lumbar Pott's disease may sometimes be confused with hip joint disease, but the limitation in movement is in extension of the hip and the other motions of the joint are unimpaired. This restriction of extension combined with rigidity of the lumbar spine, with or without lumbar kyphosis, should permit one to rule out disease of the hip joint *per se.*

Inguinal Adenitis. The hip is slightly flexed but the locally enlarged and tender lymph glands are an extra-articular source of irritation. It must be remembered that with inguinal adenitis the true hip joint motion, within a small amplitude, is never restricted in all directions. It is a principle that unless the lesion is intra-articular in character, passive motion is not restricted in every direction.

Acute Poliomyelitis. There is, in the early stages of this neuromuscular condition, a sensitiveness of all the muscles with accompanying pain on movement but there is no regional muscle spasm, and the general symptoms and laboratory findings are so distinctive that ordinarily there is no difficulty whatsoever in its differential diagnosis.

Infectious Arthritis. Another type of hip deformity caused by joint inflammation is that caused by the staphylococcus, streptococcus, gonococcus, etc., all of which can be grouped under nontuber-

culous arthritis of the hip joint. In this classification are included the *epiphysitis* of childhood, as well as the infectious arthritides. A swollen, painful fluctuating joint with a history of acute onset with or without trauma and usually accompanied by marked constitutional symptoms is characteristic of the acute type of infection involving the epiphysis and indicates prompt and decisive operative treatment. Occasionally, the *mesenteric or pelvic lymph glands* may be infected and give rise to the picture of an infection of the hip joint with its pain and soft tissue swelling. *Pyelitis, appendicitis* and *perinephritic abscess* have all been confused with tuberculosis of the hip joint, but a careful physical examination combined with laboratory data are usually sufficiently conclusive to avoid confusion on this score. *Infectious arthritis* often monarticular and chronic, may arise from some focus of infection such as tonsils, sinuses, etc., and may require observation and study within the hospital to rule out completely an acid-fast infection. Roentgenograms, the sedimentation rate, the tuberculin reaction and the removal of obviously infected foci may all give indications as to whether we are dealing with a tuberculous or nontuberculous infection.

II. TRAUMATIC ORIGIN

Traumatic Synovitis. This is a condition that should be considered whenever there is a history of a recent injury to the hip in young children. This most frequently occurs in children under eight years of age, manifesting itself by pain, limp and hip flexion deformity, while all movements of the joint may present some slight restriction to motion. In this condition there is marked tenderness in the groin over the joint with usually some muscle spasm. The roentgenographic changes, however, are negative for any bone injury or disease, and this traumatic synovitis is due entirely to injury to the synovial membrane with subsequent congestion and accumulation of joint fluid. Rest in bed with or without traction usually suffices after a week or ten days to permit a return of joint function.

Fracture of the Neck of the Femur. This fracture is not extremely rare in children, but undoubtedly many cases do go unrecognized until joint deformity has developed. The fracture is usually caused by severe direct violence to the individual, but it is very surprising how few symptoms some of these patients present. The author has had the opportunity of seeing over fifteen cases of fracture of the neck of the femur in children under ten years of age and this in children is in marked contrast to this fracture in the adult both as to the mode of onset and the disability it produces in the adult. A child may complain of nothing striking as regards the immediate effect of an injury, and may even be able to walk about with little discomfort. One case was seen three weeks after the fall. The patient complained of pain not in the hip but in the knee, and several roentgenograms had even been taken of the knee joint. On examination of this particular case the affected hip showed general restriction of motion, elevation of the trochanter above Nelaton's line with shortening and outward rotation of the limb.

The roentgenogram may show a complete fracture of the neck of the femur but more often will disclose a green-stick fracture at the cervicotrochanteric junction. This has been called a "hinge-type" fracture, and being incomplete probably accounts for the mild degree of symptoms. If not corrected, this type of fracture will give rise to a marked coxa vara deformity, though nonunion in children should not be feared. Coxa vara may be caused in a variety of ways, only one of which is a fracture of the neck of the femur. This bending or softening of the bone producing coxa vara may be of inflammatory or traumatic origin so this distortion of the neck is usually the result of a disproportion between the strength of the supportive structures and the burden placed upon it. John C. Wilson has recently reported on the slow development of an aseptic necrosis

of the head of the femur following this fracture in children, and noted this two, three and four years after the fracture and

FIG. 2. Roentgenogram of the left hip showing characteristic Legg-Perthe's disease with flattening and fragmentation of the epiphysis, accompanied by thickening of the femoral neck.

after apparently good reduction. This, therefore, is a danger to be kept in mind and warned against.

Bone Tumors. Rarely are malignant tumors of bone found involving the hip joint in children. Osteogenic sarcoma of the acetabulum occasionally is found. Pain, limp, and flexion deformity of the hip with joint limitation may develop with a cyst in the upper portion of the femur or neck. A roentgenogram will, however, easily disclose the bone changes that cause the symptoms and occasionally a fracture through the cyst may be the first evidence of its presence.

Growing Pains. This vague term is probably due to muscle strain and rarely runs a chronic course or produces much discomfort. No real difficulty in differentiating it from actual joint disease or injury should be encountered, although the symptoms may resemble those of an infectious arthritis in its early stages.

III. EPIPHYSEAL DISTURBANCES

Coxa plana, Legg-Perthes' disease, Perthes' disease, or osteochondritis deformans juvenilis, the latter term more clearly describing the pathological condition, was frequently confused with tuberculosis of the hip before the introduction of the roentgenogram. Most authors agree that this condition is an aseptic necrosis of the head of the femur caused by interference with its circulation. But others hold that it is related to disturbances of the glandular system even though there is very little proof to substantiate such a theory. Clinically, it closely resembles tuberculosis of the joint, although the prognosis is much better for ultimate joint function. It manifests itself by pain, limp, muscle spasm and atrophy, but in addition to its clinical course it presents a roentgenographic picture distinct from tuberculosis. The roentgenogram shows a characteristic flattening or roughening of the upper epiphysis of the femur as though this portion of the bone had become softened and flattened from pressure. (Fig. 2.) The femoral neck is broader and there may be a slight coxa vara present. Legg has described two forms of the disease, one presenting a so-called "capped" type of epiphysis and the other having a "mushroom" effect, and believes that the latter type offers a more favorable prognosis for the recovery of joint function. This condition is only found early in childhood, rarely before four or after ten years of age.

Epiphyseal Fracture. This slipping of the upper femoral epiphysis is a condition that may develop without any trauma or apparently a slight injury and occurs in the puberty age group between eleven to fifteen usually. There is definitely a traumatic and nontraumatic type, the latter being the most frequently seen in the fat, adolescent, Froelich type of individual. The injury causing it and the immediate disability may be so slight that the condition may be unrecognized and treated for a long time as a "bruise of the hip." The displacement of the upper femoral epiphysis is down-

ward and backward producing the signs and symptoms of limp with varying degrees of discomfort. (Fig. 3.) There is

Fig. 3. Roentgenogram showing characteristic appearance of right slipped femoral epiphysis. Epiphysis has slipped downward and backward, which is the usual position the head assumes in the deformity.

definite limitation of joint motion in internal rotation and abduction. The characteristic attitude is an adduction deformity with outward rotation of the limb and restriction of internal rotation by bone block and muscle spasm. It is very important to diagnose and properly treat these patients early in the pre-slipping stage if a restoration of normal function is to be obtained. The most satisfactory method, we believe, is to reduce the slipping at the time by open operation on the hip and by graft, drill or pin, produce an early fusion of the capital epiphysis to the neck of the femur. This permits a restoration of joint function and prevents subsequent slipping.

CONCLUSIONS

This brief résumé in the differential diagnosis of the conditions to be found in children complaining of "pain in the hip" must necessarily be rather incomplete, but an effort has been made to stress the more commonly observed conditions in orthopedic practice.

The need for careful history taking and physical examinations cannot be overemphasized and an adherence to these basic principles will automatically eliminate certain conditions. Added to these basic principles the use of good roentgenograms and various other laboratory aids, one can early and correctly make the differential diagnosis in the child who complains of "pain in the hip."

PRIMARY BRONCHOGENIC CARCINOMA OF THE LUNG*

A CLINICAL AND ROENTGEN STUDY OF THIRTY-EIGHT CASES OVER A PERIOD OF TWELVE YEARS

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THAT controversy exists on the subject of primary lung carcinoma is well recognized. The consensus of opinion amongst most pathologists clings to the thought that lung carcinoma arises from the bronchial epithelium and that there is no epithelium lining the alveolus. The classification of lung carcinoma is varied and confusing. In the literature, one is impressed with the variations offered by pathologists and clinicians. While it is true that varied types may exist in one tumor and frequently are so found on the postmortem table, the classification is still much to be desired. Metaplasia of bronchial epithelium has been found notably in bronchiectasis, in influenza, in chronic bronchial fistulae and in bronchial mucosa subjected to trauma. What rôle these morphologic changes play in the etiology of carcinogenesis and the phenomena of chronic irritation is still unsettled. Tuttle and Womack, in a study of seventy-six cases of primary bronchiectasis in adults of cancer age were able to find only one case which developed bronchogenic carcinoma.[1] It is conceded that benign tumors of the bronchi are rare, and that by far the greater number is malignant. There is still much controversy as to whether the so-called adenoma of the trachea or bronchus is benign or malignant. Chevalier L. Jackson has reported some of these tumors as benign adenoma, while Leddy and Moersch in a recent article found eight adenomas in the trachea and main stem bronchi which they classify as malignant.[2] The same authors report twenty-five cases of a group of 125 treated by roentgen irradiation, living from twelve to 147 months, and in this survival number of twenty-five, eight were adenomas. On the other hand, best surgical opinion believes in total pneumonectomy and not lobectomy for the best possible results for radical cure. Bold advances in surgery and possible better technic in roentgen irradiation offer some ray of hope for the future to combat this deadly affliction and to overcome the present hopelessness as exists in the average case.

Some thirty years ago, the medical profession entertained a unanimity of opinion and considered carcinoma of the lung as a hopeless disease, that its treatment was of little or no avail. In the early days recognition of lung cancer during life was very rarely or not made at all and was labeled a postmortem curiosity. As one familiarizes himself with the increasing literature on the subject, he is impressed with the apparent hopelessness in a very high percentage of cases; or in other words, it is the exceptional case that escapes inevitable doom, and if it weathers the storm by operation will survive. Since Adler's publication in 1912, the literature is increasing and for the past ten years, enough material has accumulated for the clinician to secure a very comprehensive foundation for a study of this disease.[3] Because of its increasing frequency, it has ranked as a tumor of major importance, equalizing in occurrence carcinoma of the large bowel.[4] In fact, tumors of lesser consequence have received greater atten-

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Fig. 1.

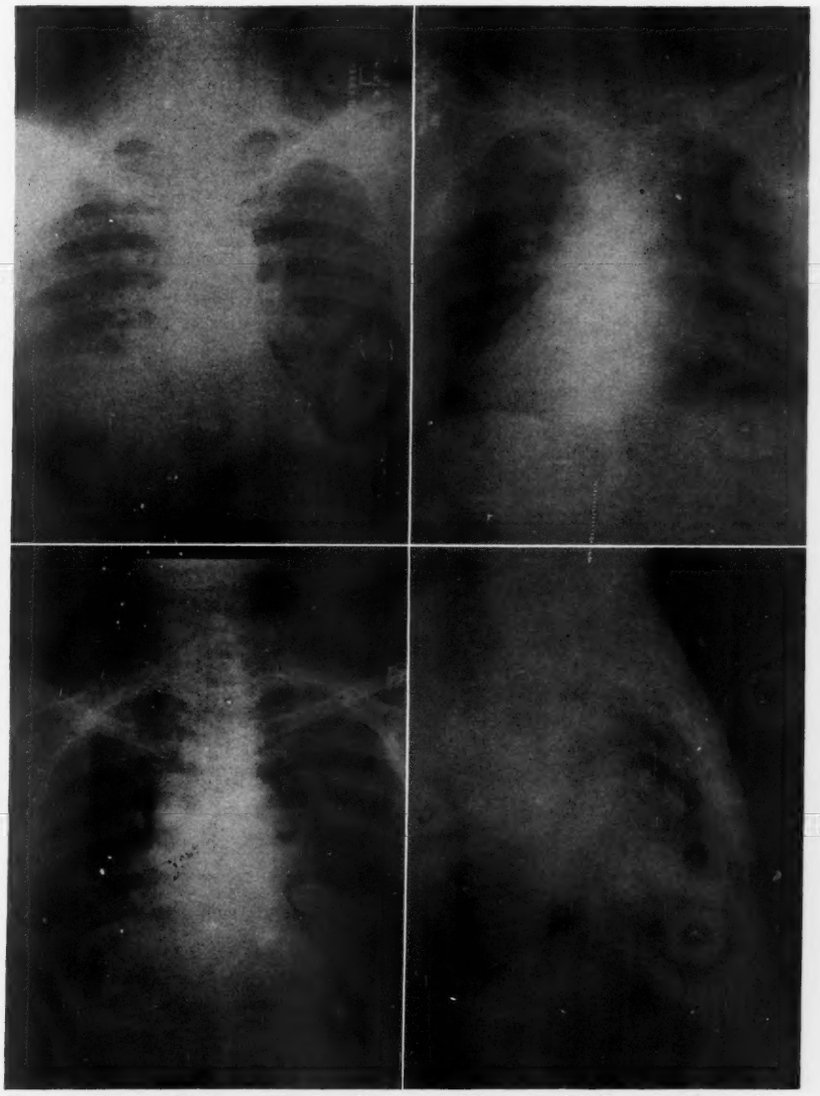

Fig. 2

Fig. 3.

Fig. 4.

Fig. 1. Case 1. D. L., male age fifty-two. History of influenza November, 1933, followed by pneumonia on left side and recovery. January, 1934, fractured anterior sixth to eighth ribs right side followed by pleurisy. Operation, March, 1934, for encapsulated pus pocket. April, 1934, had resection of eighth anterior rib for encapsulated empyema. Pleura considerably thickened and adherent to lung. Examination of lung revealed inflammatory tissue. May, 1934, chronic empyema draining intermittently for eighteen months with bronchial fistula. January, 1936, second rib resection. Pleura incised, cavity found 5 by 2.5 cm. with smaller cavities surrounding larger one. Patient discharged with small draining fistula. *X*-ray taken March 19, 1934.

Fig. 2. Case 1. D. L. May 18, 1936. The patient gained forty pounds since discharge. Note scarring lung at right base.

Fig. 3. Case 1. Readmission June 1, 1937. Note mass at right base. Recurrence of symptoms one month prior to admission.

Fig. 4. Case 1. Note extensive involvement of tumor mass of lung along mediastinum and posterior upper and middle lobes. Patient died September 21, 1937. Autopsy findings: (1) Extensive round cell carcinoma involving right main bronchus with extension to right middle and lower lobes. (2) Compression of mid portion of esophagus and superior and inferior vena cava by tumor mass. (3) Extensive metastases to right pulmonary hilus lymph-nodes, nodes of pancreas and spleen, duodenum, mesentery, peri-aortic and right axilla. (4) Fibrous obliteration right pleural cavity. (5) Edema of face. Lateral view taken June 1, 1937.

tion than lung carcinoma. It is said to comprise from 5 to 10 per cent of all carcinomas, and some writers even exceed these figures. In the Woodlawn Clinic and Hospital, the number of malignancies of all types from June 1, 1928, to June 1, 1940, comprise a total of 815. In this series are found thirty-eight cases of primary bronchial carcinoma, a percentage of 4.7. All suspicious and secondary tumors of the lung are excluded. In this total of thirty-eight cases, nineteen came to postmortem examination. Since some of the patients expired in other institutions, we are unable to secure sections for microscopical study in six cases.

A biopsy of a gland was obtained in three cases. Bronchoscopy was performed in two cases. One patient came to operation in another hospital and expired. One patient was operated upon three times, first for an empyema, second for a subsequent fistula and third because of a localized abscess which developed. Eighteen months later, this patient developed bronchial carcinoma. (Case 1.) (Figs. 1, 2, 3 and 4.) One patient was operated upon for a spinal cord tumor which proved to be metastatic. In one case, there was aspiration of the chest in which hemorrhagic fluid was obtained and which yielded cancer cells. In nineteen cases from the history, progress and Roentgen findings, we have considered these tumors primary carcinoma of the bronchus as our intimate studies of this group, render this diagnosis a justifiable one.[5,6] In this series thirty-two patients are dead, the outcome in five are unknown and one is still living. As our knowledge of the subject increases, it is apparent that by far the greater number of cases come to the physician late, at which time therapeutic measures are of no avail, surgery is out of the question, and the disease is so far advanced that the patient and family are often unaware of the critical condition. In this series of thirty-eight cases covering a period of twelve years, only two cases could be considered early and one of these patients refused any type of therapy. The other submitted to a pneumothorax prior to surgical removal but when the base of the lung was discovered adherent to the diaphragm, surgery had to be abandoned. (Case 11.) In 300 cases that Graham studied only twenty-eight were considered early, again demonstrating that by far too many reach the physician in an advanced state. It is true that any physician familiar with the disease can recognize it by the history, progress, physical examination and a Roentgen study by a short series, in the greater number of cases.[5] Biopsy of a lymph gland, whether cervical, supra- or infraclavicular, or axillary, or a node in the skin distant from the chest wall will sometimes yield the necessary information. Examination of the pleural fluid or sputum for carcinoma cells or bits of tissue offers another avenue for diagnosis. A puncture aspiration directly into the tumor for histologic data has lately been advocated and has developed many adherents for this type of diagnosis, a method available wherein other measures are not possible to obtain.[7] So far, there have been mentioned four avenues for a possible diagnosis: (1) tumor tissue in sputum, (2) pleural effusion, (3) gland or skin biopsy and (4) lung puncture. The fifth requires greater emphasis, since in 70 to 75 per cent of cases, a diagnosis is made from tissue obtained by bronchoscopic examination. Graham concludes that 80 per cent of tumors causing bronchial obstruction can be diagnosed by bronchoscopy.[8] In Arkin and Wagner's series of 135 cases, only thirteen were confirmed by tissue removed by bronchoscopy. In the authors' series of thirty-eight cases, only two diagnoses were made by bronchoscopy. In sixty cases studied by Hochberg and Lederer,[7] less than twenty-two had a bronchoscopic examination. (Diagnosis in twenty-two cases included bronchoscopy, biopsy of lymph-nodes or malignant cells in sputum and pleural fluid.) Jackson is of the opinion that seventy-five per cent of cases of bronchial carcinoma can be recognized by bronchoscopy; and here it may be perti-

nent to add that in some clinics and in some of the cases reported by the writers, patients presented themselves with far advanced disease. Occasionally, in the extra pulmonary cases, the lung tumor may have been small but the metastatic focus may have precipitated the symptomatology, thus tending to confuse the clinical picture.[9] Another factor enters the problem. Tumors of the major bronchi cause symptoms early, grow more slowly and are more amenable to treatment, whereas tumors at the periphery of the lung and smaller bronchi result in fewer early symptoms; in this latter group, can be classified the so-called silent tumor which by its slow progressive growth, gives rise to symptoms or distant metastasis late in the disease. Hence, when seen in this stage, the disease becomes rapidly fatal.[1] Perhaps in no disease is the dissemination of metastases so widespread. No organ is exempt and metastases to the skin and bones are relatively common occurrences. A distant metastatic focus may usher in the disease by symptomatology that leads the clinician away from the lung and one must be on the "alert" when these foci occur, to consider bronchial carcinoma as a possibility. (Table 1.)

TABLE 1
METASTASES—SIX CASES

	Cases
Mediastinum	
Glands right hilum	
Pancreas	
Spleen	
Appendix	
Duodenum	
Mesenteric lymph-nodes	
Peripancreatic lymph-nodes	
Periaortic lymph-nodes (3 cases)	
Right axillary lymph-nodes	
Glands—right and left hilum tracheobronchial	4
Liver	4
Heart	2
Muscles of thigh, kidney, dura	
Dorsal and lumbar spine	
Skull	2
Iliac bones	
Sacrum	
Ribs	
Bladder mucosa	
Skin	2
Suprarenal	2
Vaginal wall	
X-RAY METASTASES No autopsy	
Ribs	
Pelvis	
Sacrum	

SYMPTOMATOLOGY

No disease offers a more varied group of symptoms than bronchial carcinoma. The symptoms are as protean as the physical findings and in a great measure depend upon the location and extent of the tumor. From the outset it can be stated that there is no group of symptoms or physical signs which can be considered pathognomonic of the disease.[7,10] It is a remarkable finding that many patients even in the advanced stage appear in good nutrition and one would never outwardly suspect malignant disease. Even in advanced disease in many instances the blood picture is little affected or unchanged. In the main, the symptoms are due to pressure and obstruction. It is perhaps essential to keep in mind two groups of symptoms: those due to pathological changes in the lung and secondly, symptoms caused by a metastatic process distant from the lung. A small primary tumor in the lung may yield no chest symptoms but symptoms may be caused by some distant metastatic focus which may complicate the clinical picture. Even a serial roentgenographic study of so short a period of three or four weeks denoting the progress and increase in size of the tumor will add to the greater probability that one is dealing with bronchogenic carcinoma. In fact, one plate taken during this period in several of the writers' cases a month apart, strongly added to the suspicion of lung carcinoma. Here the roentgenologist may be of immense aid and at least fortify the suspicion of the clinician. We wish to emphasize that the combined teamwork of the clinician, bronchoscopist and radiologist offers the ideal setup for the best interests of the patient where teamwork is a routine in the various clinics. Even independently the radiologist can be of much aid and value, for frequently the first suspicion is sug-

gested by the *x*-ray. One should not slight a good history which in many cases can be considered the keynote for intensive additional study to confirm the suspicion.

Cough, chest pain and weakness are the leading symptoms in the greater number of cases. To this may be added blood-stained sputum, simulating tuberculosis, and progressive increasing weakness. Loss of weight is another important factor in some cases. In our series these were the main symptoms in about one-half of our cases, cough heading the list in eighteen cases. Next, neuritis and pain from distant metastases occurred in seven cases. Two cases were ushered in by symptoms referable to the genitourinary tract, as dysuria and a mass in the vaginal wall of one year's duration; the other case presented a distant mass in the lower right quadrant of the abdomen. Six cases had a massive pleural effusion which was hemorrhagic; one case was an encapsulated effusion, the typical straw color being present that is so common in the average effusion. One case was introduced by symptoms referable to the spinal cord: severe pain down both arms and between both shoulder blades due to metastases, extradural, and masses causing necrosis of the ribs and pressure but without cord metastasis. Two cases followed chronic inflammation of the lung, and in the sequence of events that occurred later, were empyema, fistula, lung abscess, recurrence of the fistula, then a lapse of eighteen months—in which period the patient gained forty pounds and looked well—and finally the appearance of an extensive carcinoma. The original pathology was several fractured ribs which happened in a motorcycle collision. (Case 1.) (Figs. 1, 2, 3 and 4.) The other bronchial carcinoma developed after pneumonia followed by pleural effusion, resolution and a persistent hard unyielding cough covering a period of over a year. (Case 11.) (Figs. 5, 6, 7, 8, 9, 10 and 11.) One other case, a man of sixty-two came to his doctor with severe low back pain. Upon *x*-ray examination, an area of bone destruction was found in the ilium and sacrum. A lung plate revealed a mass suspected as bronchogenic carcinoma which was verified later on postmortem examination. At no time in the course of this patient's illness was complaint made of symptoms referable to the chest.

Perhaps the main group of cases may classify their symptomatology as due to pressure and obstruction. While it is true that cough, dyspnea, blood-stained sputum and chest pain form a composite suspicious picture of bronchial carcinoma, an understanding of the relation of symptoms to lesions will simplify the clinical picture. Due to a growth in the bronchus, the cough is first irritating and persistent. If ulceration occurs, the sputum becomes blood tinged. If a bronchus is occluded, atelectasis develops; and if a large bronchus is involved, the heart, trachea and mediastinum are drawn to the affected side. The slow development of atelectasis is considered an important sign of bronchial carcinoma brought out very dramatically by roentgen examination. According to Chevalier Jackson, comparable to valve mechanism, there are three types of obstruction: (1) complete or stop-valve obstruction, resulting in no entrance or no exit of air into a tributary of lung and causing a slow atelectasis from the absorption of the contained air; (2) by-pass valve obstruction in which a lessened amount of air passes in and out of the lung, and (3) check-valve obstruction, in which air can pass only one way, either in or out, rapidly causing atelectasis or emphysema, as the case may be. A mobile tumor protruding and flapping in a bronchus or viscid secretion may form a ball-valve mechanism causing this latter type of obstruction. Atelectasis may also result from pressure of the growth surrounding the bronchus. Collapsed lung and tumor at times appear as one dense shadow and frequently are thus interpreted as tumor shadow alone.[6,11] Pressure on neighboring organs or structures may cause symptoms referable to the part involved. Pressure on the esophagus may cause dysphagia, on the trachea

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 5. Case 11. G. A. S., male age forty-five. Admission to Woodlawn Clinic April 26, 1938. History of pneumonia in spring of 1937 followed by chest pain and constant unyielding unproductive cough with slight remissions of seven months' duration. *X*-rays of Figures 5 and 6 were brought into clinic by patient. Note tumor mass in upper portion of left lower lobe; taken October 9, 1937; left lateral view.

Fig. 6. Case 11. Lipiodol study. Note irregular distribution in left lobe (upper and middle portions). (Print made from *x*-ray brought by patient.) Taken November 30, 1937.

Fig. 7. Case 11. *X*-ray taken day of admission to Woodlawn Clinic April 26, 1938. Note tumor mass and area of atelectasis as one shadow, left lower lobe. Greater density at left hilum and "thinning out" toward outer zone of lung. Bronchoscopy about one month later revealed squamous cell carcinoma from aspirated fluid.

Fig. 8. Case 11. November 14, 1938, seven months later. Note pneumothorax left chest. Base of lung found adherent to pleura. Surgery had to be abandoned.

stridor, on the recurrent laryngeal nerve, aphonia, on the cervical sympathetic, Horner's syndrome.* In one of our cases,

Fig. 9. Case 11. April 17, 1939. Note extensive growth of tumor in left lung. Patient died September, 1939.

there was transient cyanosis and edema of the chest wall which occurred on arising and gradually disappeared at noontime, due to pressure of the tumor on the great vessels and release of pressure in the morning. Dyspnea was a prominent symptom in ten of our cases. Whether this is of cardiac origin, due in some instances to the heart drawn over in atelectasis, causing interference in its action or elimination of a portion of the lung's function by solid tumor, is debatable. Chest pain occurred in eight of our cases probably due to early involvement of the pleura followed by effusion—one of the main direct causes of dyspnea. Pain is also caused by pressure on nerves or bone metastases of the thoracic cage or skeleton. Four cases had a pronounced brachial neuritis, severe pain down the entire length of one arm, from pressure of metastatic nodules. (Table 11.)

Fever is a common symptom and as a rule occurs when the tumor breaks down and disintegrates; there is invariably contamination with secondary organisms and leucocytosis may develop. With partial regression of the infection, the fever may

Fig. 10. Case 11. Squamous cell carcinoma—low power magnification. × 100. (Courtesy Dr. A. C. Strunk.)

disappear and the patient may enjoy a temporary respite and feel better. This transient improvement may lead the physician astray, thinking that he is dealing with infection of the lung and not with tumor. This cycle of events is not uncommon in some cases as there is a recurrence of symptoms, and the patient is again troubled with a renewal of symptoms and increasing weakness. (Case 11.) Tuberculosis may simulate the tumor in this stage. If the tumor breaks down and establishes a

Table 11

LEADING SYMPTOMS—THIRTY-EIGHT CASES

1. Cough	18
2. Blood stained sputum	8
3. Chest pain	8
4. Dyspnea	10
5. Loss of weight	8
6. Weakness	13
7. Neuritis (brachial)	4
8. Distant metastasis-sacral pain	3
9. Genitourinary symptoms	2
10. Vaginal mass	1
11. Chronic inflammation (lungs)	3
12. Mass R. L. Q.	1

* Horner's syndrome may consist of the following phenomena: ptosis of the upper lid, myosis, anidrosis, enopthalmos and paralysis of one or more of the vocal cords or of the diaphragm.

fistula leading to a bronchus, it may easily simulate lung abscess from which it may be very difficult to differentiate. Cough is troublesome at this time and expectoration is profuse. A purulent bronchitis may supervene and the breath becomes foul. The sputum will yield bits of necrotic tissue and cancer cells and a diagnosis may be established. Usually when this stage has been reached, the tumor is advanced and if the diaphragm or pleura are involved, surgery is useless.

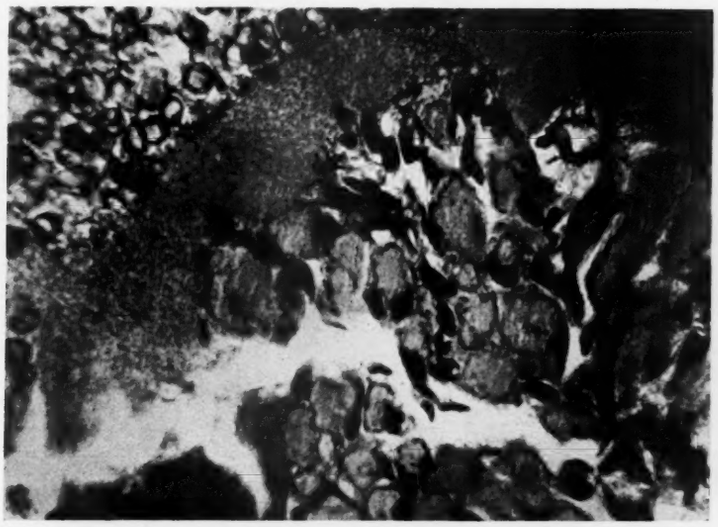

Fig. 11. Case 11. Squamous cell carcinoma. High power. Note stratified pavement arrangement of cells. Figures 10 and 11 courtesy of Dr. A. C. Strunk. × 440.

ANATOMIC SITES IN RELATION TO SYMPTOMS

For a better understanding of bronchial carcinoma an anatomic survey of location of the tumor in relation to symptoms, affords a very comprehensive background, simplyfying the pathological and clinical aspects. We are indebted to Churchill in Christopher's Textbook of Surgery for this all-inclusive study.[12] Referring to diagram 1, the numbers represent the location of the tumor. It must be remembered that this diagram does not embrace all the aspects of bronchial carcinoma but covers the greater number of lung tumors. Differences from this survey are encountered and are to be expected from an entity which manifests so many variations:

1. The tumor is in close proximity to the visceral pleura which it invades causing an effusion. (About 50 per cent are hemorrhagic.)

2. The tumor is in the outer zone of lung, begins in smaller terminal bronchus or may be silent or accidentally discovered by *x*-ray. This type because of its fewer early symptoms is rapidly fatal. (Silent tumor.)

3. Tumor here usually results in occlusion of sizeable bronchus—tributary of lung becomes atelectatic and "drowned" by bronchial secretions. Bronchi may dilate and with bacterial invasion form lung abscess.

4. The tumor in the apex may invade adjacent structures; (so-called superior sulcus tumor of Pancoast) causing (a) paralysis of sympathetic trunk resulting in Horner's syndrome, (b) invasion of first dorsal trunk of brachial plexus giving pain referred to arm. A tumor may not be detected early. This occurred in one of our cases. The patient was treated for many months for neuritis, finally referred to clinic which on roentgen examination disclosed caries of transverse processes, lower cervical spine and upper ribs from metastases of bronchial carcinoma. (Proven by autopsy.)

5. Primary tumor or metastatic deposit may cause paralysis of recurrent laryngeal nerve or phrenic nerve on involved side.

10. Tumor invading esophagus producing ulceration or obstruction.

Many tumors as 1, 2, 3, 4, 5, 6 and 9

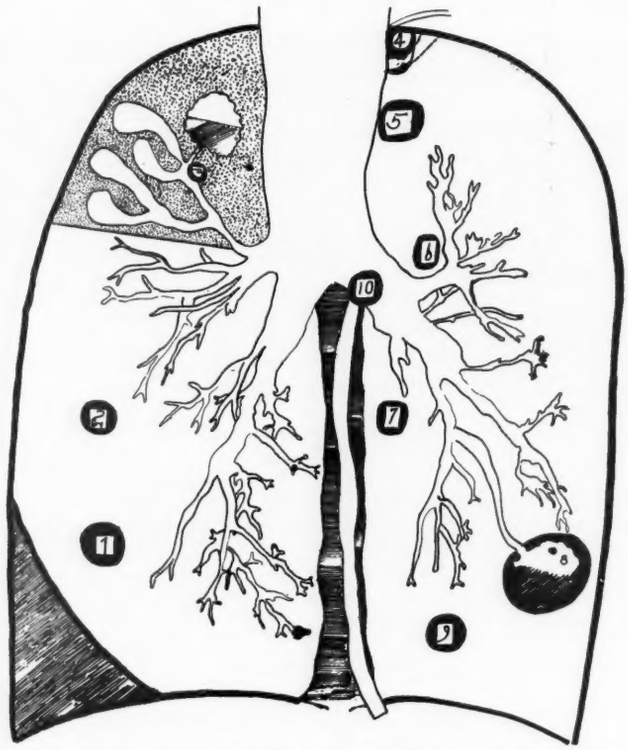

Diagram 1. (From Christopher, Frederick. Text Book of Surgery, p. 931. Philadelphia, 1939. W. B. Saunders & Co.)

6. Tumor here obstructs large bronchus, causes "wheeze" to patient and sibilant râles to examiner—symptoms of foreign body, partial or complete—partial obstructive bronchus may cause obstructive emphysema (trapping of air on expiration); *x*-rays taken on full inspiration show density and in full expiration reveal rarefaction. Recurring attacks of pneumonitis punctuate history.

7. Tumor causes ulceration of bronchial mucosa and gives rise to hemorrhages—diagnosis of tuberculosis should be questioned in absence of negative sputum.

8. Tumors undergo central necrosis with cavitation and establishment of bronchial fistula, simulating lung abscess—may be difficult to differentiate.

9. Tumor causes irritation of central portion of diaphragm giving typical phrenic nerve distribution as first symptom.

may not be reached by bronchoscope, hence negative evidence does not exclude carcinoma.[12] (Diagram 1.)

METHOD OF SPREAD—METASTASES

Bronchial carcinoma spreads through the lungs and invades the regional lymph-nodes; this may occur through (1) the blood stream, (2) the lymphatics and (3) extension through aspiration in the uninvolved or new portions of the affected lung. Dissemination of metastatic foci is extensive and widespread and involves many of the solid viscera besides the lungs, the brain, dura, skeleton, the vertebrae and skin. Nodes about the aorta, pancreas, spleen, liver and stomach are usually involved in widespread metastases. The heart, kidneys and suprarenals may likewise be involved. In one of our cases, the muscles of the thigh showed metastatic

nodules. It has been stated, that if autopsy investigation presents tumors of the lung, brain and adrenals and the histology reveals small round cells of the undifferentiated type, one need have no hesitation to diagnose primary carcinoma of the lung.[13] Statistics seem to strengthen the fact that bronchogenic carcinoma gives rise much more frequently to metastases of the brain and adrenal than cancer elsewhere in the body. Not infrequently has a brain tumor been removed only to find later that it was metastatic and the primary seat was in the lung. Now every brain tumor follows a procedure which routinely obtains a lung plate prior to surgery. (Table 1.) (Diagram 2.)

PATHOLOGY

Associated pathology may comprise the following as found in the material of thirty-eight cases. The pathological involvement of tumor to neighboring organs and structures is included.

Table III
ASSOCIATED PATHOLOGY

Atelectasis
Emphysema right lung (obstructive)
Thrombosis main branch pulmonary artery
Hydrothorax
Ascites
Bronchiectasis
Fibrous obliteration right pleural cavity
Edema of the face
Edema of the face and neck
Active and chronic miliary tubercles
Pneumonia—bronchopneumonia
Lung abscess

Table IV
PATHOLOGICAL INVOLVMENT OF TUMOR TO NEIGHBORING ORGANS AND STRUCTURES

Compression of mid esophagus	
Superior and inferior vena cava by tumor mass	
Compression of tumor metastases on spinal cord	
Clinical observation	
Cyanosis and edema transient in one case	
Occurred on arising and disappearing toward noontime	

LOCATION OF TUMOR

The location of the tumor was found in the right lung in twenty-one cases and in the left lung eight times. In two cases the tumor masses were so diffuse as to make it impossible for the pathologist to determine the site of the primary tumor. A hemorrhagic effusion occurred in six cases, four on the left side and two on the right. One encapsulated effusion was met in the right chest—straw colored fluid was present

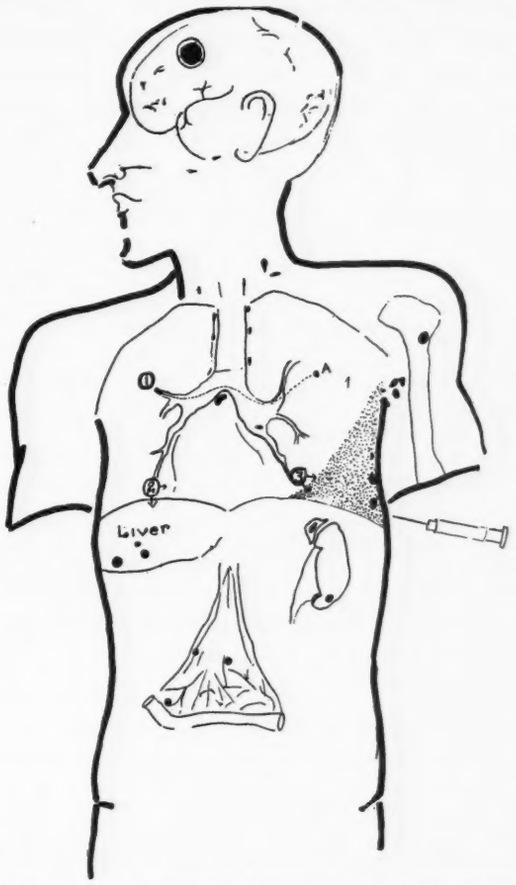

Diagram 2. (From Christopher, Frederick. Text Book of Surgery, p. 930. Philadelphia, 1939. W. B. Saunders & Co.) Tumor (1) giving rise to metastases to nodes about trachea and at bifurcation of bronchi. Metastases may occur by way of lymph, blood stream and by the aerogenous route, that is conveyed to a distant part of the lung by cough, as at A, a secondary focus. Direct extension to mediastinum is a common occurrence and there is frequent invasion of the pericardium, great vessels or heart and pericardium. Tumor (1) may also serve as an example of the silent tumor, located in the outer zone of the lung which may give rise to metastases in the brain, adrenal kidney and masses in the omentum. Tumor (2) at base of right lung may extend into liver. Tumor at (3) with extension to the pleura causes a pleural effusion (usually hemorrhagic) and from which "cancer cells" may be found. Metastases from this tumor may occur to axillary glands and to skeleton as humerus.

which contained no cancer cells. In six of these cases, the effusion concealed the tumor and only after fluid was withdrawn could the nature of the tumor be determined. The roentgen features will be described in the paragraph on roentgen findings. Below is the table on location of tumors and pleural effusions.

TABLE V
LOCATION OF TUMOR—LOBES INVOLVED
THIRTY-EIGHT CASES

Right upper	2	Left upper lobe	1
Right upper lobe and left hilum	5	Left lower lobe	6
Right middle lobe	4	Left hilum	1
Right hilum	3		
Right lower lobe–left lower lobe	1		
Right middle and right lower lobe	1		
Right lower lobe	4		
Right lung	1		
Diffuse	2		

Hemorrhagic Pleural Effusion

Left	4
Right	2
Encapsulated effusion right (straw colored)	1

SEX AND AGE

In the series of thirty-eight cases, there were twenty-eight males and ten females, a ratio of about 3 males to 1 female. Twenty-one cases occurred in the fifth and sixth decades which seemed to bear out the statistics in the literature.

INCIDENCE AS TO SEX AND AGE

Decade	Male	Female	Total
Fourth	6	3	9
Fifth	10	1	11
Sixth	11	4	15
Seventh	1	2	3
	28	10	38

ETIOLOGY

From a study of the material, one is not able to place any definite facts or suggestions as to the probable etiology of bronchogenic carcinoma. In the twenty-eight males, most of them were smokers as well as eight of the females. Arkin and Wagner found 98 per cent of their patients were chronic smokers. This may be a contributing factor, but in addition, exhaust gases from automobiles, tar on roads, and chronic inflammation are others. Any chronic inflammatory process of the lung can be considered a contributing factor. Inhalation of various dusts and radio-active substances has also been found as contributing factors. The histologic changes of bronchial epithelium brought out by Tuttle and Womack, when this tissue has been subjected to trauma and chronic irritation, are of much interest. Whether hyperplastic and metaplastic changes are precursory steps in carcinogenesis open up an attractive field for investigation, but suffice it to say that these morphologic changes do occur. These same authors in a study of seventy-six cases of bronchiectasis were only able to find two cases of bronchogenic carcinoma. What rôle syphilis or tuberculosis may play in the etiology of cancer is not known, but as a whole, these diseases do occur in association with carcinoma. Jaffe in a study of one hundred cases found 20 per cent of carcinoma associated with anatomic or serologic evidence of syphilis which is rather high compared to the statistics of other authors. This high incidence of syphilis in lung carcinoma may be due to the high percentage of colored patients in Cook County Clinic. Active tuberculosis is mentioned as an infrequent finding associated with lung carcinoma.[14]

Grossly three forms are recognized by pathologists: (1) The hilus form which Boyd believes constitutes 90 per cent of all tumors; (2) the miliary form which resembles metastasis from a distant focus and also resembles miliary tuberculosis, and (3) the diffuse form which may involve a part or an entire lobe or a whole lung and closely resembles pneumonic consolidation.

MICROSCOPIC PATHOLOGY

There is much confusion among pathologists as to the classification of bron-

chogenic carcinoma. Recent authors have demonstrated that the so-called round cell, oat and spindle cell carcinomas unquestionably arise from the bronchial epithelium. The majority of pathologists concede that most of the tumors arising in the bronchus are malignant and that benign tumors are extremely rare. Prevailing opinion seems to be that carcinoma arises from the bronchial epithelium since there is no epithelium lining the alveolus. Most pathologists offer this classification: (1) squamous, (2) adeno-carcinoma and (3) small cell type, oat or fusiform. Many variations from these three have been recorded but by far the greater number fall into these three groups.

The following data reveal the microscopic findings from three sources.

JAFFE[14] 100 CASES (POSTMORTEM)
31 round cell (undifferentiated)
28 squamous
24 adenocarcinoma
88 oat cell carcinoma
4 carcinoma simplex
2 scirrhus carcinoma
3 goblet cell carcinoma

KOLETSKY[15] 100 CASES (POSTMORTEM)
35 small cell carcinoma
40 squamous
22 adenocarcinoma
3 carcinoma simplex

WOODLAWN CLINIC 19 CASES (POSTMORTEM)
7 squamous carcinoma
1 round cell carcinoma
2 alveolar carcinoma
1 mixed cell carcinoma
6 no microscopic obtainable
1 adenocarcinoma
1 medullary carcinoma

Many authors agree that the grading of bronchogenic carcinoma on histologic grounds is of little practical value. These types of tumors do not differ in their gross appearance neither are there any appreciable differences as to the duration of life or extent of metastases.[1,4] Graham classifies them into two large groups: 65 per cent squamous and 35 per cent mixed.[8] He believes that the mixed type in a young person is potentially malignant, and for the best prognosis favors early removal of the lung. Arkin and Wagner believe that the squamous type is less malignant than other forms and offers the best prognosis for early surgical removal, although six of their eighteen cases, had brain metastases. The squamous type presented metastases in the liver, kidney and adrenals, one third as less frequent as in the other forms.[5] Because of its comparatively slow growth, the squamous cell type offers the best prognosis for early surgical removal. Many authors in the recent literature hold a similar opinion.[6,8,15]

ROENTGEN FINDINGS

As a primary requisite, it must be emphasized that there are no roentgenologic findings characteristic or pathognomic of bronchial carcinoma. What then are the criteria which may guide the roentgenologist or clinician? The writers have previously stated that the teamwork of the clinician, bronchoscopist and roentgenologist best serve the patient for a proper diagnosis. In order of first importance may be considered a unilateral shadow at the hilum which is not due to increased vascular markings and whose border may be well circumscribed or fades into the parenchyma as a "feathery" cloudy density. This shadow is considered one of the earliest signs of bronchial hilus carcinoma and may be due in some measure to invasion in and surrounding the bronchus. Next in importance is atelectasis due to partial or complete bronchial obstruction, whether caused by invasion of the lumen or by peribronchial pressure of the invading tumor. The atelectatic area may involve part or the whole lobe or the entire lung, depending primarily on the degree of stenosis, the location and extent of the site of obstruction. The resulting collapse of the involved lung area, displaces the heart, trachea and mediastinum to the affected side. The imprisoned air, as previously described, undergoes slow absorption, and there ensues local edema. If secondary infection occurs, multiple small abscess cavities develop, resembling localized bronchiectasis. Usually, the atelectatic lung is

roughly triangular in shape and if small may possess a well defined dense border. As the tumor grows, the bronchial wall is

Fig. 12. Case III. R. B. P., male age forty-two. Nervousness and irritability for one year. The patient was admitted to Woodlawn Hospital October 11, 1937. He had pain in the left chest of a neuralgic type, rather severe one week prior to admission. Slight cough was present. Fluid in left pleural cavity masks tumor. Note heart in normal position. Aspirated fluid, hemorrhagic.

perforated and invades the parenchyma. Eventually, large areas of infiltration cause consolidation of part or the entire lobe or lung and are visualized as dense massive shadows. The periphereal type of tumor occurring in the smaller terminal bronchi and distant from the hilum (at times, the so-called silent tumor) may or may not be associated with atelectasis. By its slow growth it is apt to cause fewer early symptoms and usually is first encountered in an advanced stage. If part necrosis of the tumor does occur, small cavities develop and with bacterial invasion, bronchiectasis follows; coalition of the cavities gives rise to the formation of lung abscess. With the tumor in an advanced stage, it is frequently impossible to decide whether the type is peripheral or central. Secondary processes render it more difficult to differentiate basic pathological changes. The table of associated pathology represents the findings in our series of thirty-eight cases.

A few remarks in relation to pleural effusion should not be omitted. Jaffe in one hundred cases encountered forty-three with pleural effusion. The character of the exudate was as follows: serous, fourteen cases; hemorrhagic, thirteen cases; suppurative, twelve cases; fibrinous, four cases. In addition, there were twenty-six cases of partial and twenty-three cases of complete obliteration of the pleural cavity. Only eight cases revealed no pleural changes.[14] Our series of thirty-eight cases demonstrated six hemorrhagic pleural and one encapsulated (straw colored) effusions. The tumor may be concealed by the effusion and it is our policy to radiograph the chest as soon as possible after removal of the fluid on account of rapid reaccumulation. In several of our cases the fluid did not cause displacement of the heart even though large effusions of 1500 cc. and over were obtained. (Case III, Fig. 12.) This finding has puzzled us and so far we have been able to offer no satisfactory explanation. However, it has made us consider lung malignancy as a possibility when this phenomenon occurs. We also believe injection of air (at least 200 cc.) after aspiration is a good procedure to follow as it makes the tumor outline more visible. (Case III, Fig. 12.)

CONCLUSIONS

Primary cancer of the lung still remains a problem both as to early diagnosis and treatment. By far too many cases are first seen when the tumor is well advanced. The solution of the problem is for early diagnosis and is similar in scope to the entire cancer situation; namely, education of the public, and an earnest attempt by the physician to recognize the condition in its earliest stages. The writers are impressed reviewing the literature with the apparent hopelessness of the disease, but one can become "cancer conscious" especially in an adult over forty who presents leading

symptoms such as chronic cough and bronchial obstruction, chest pain, dyspnea, and so forth, in short, pulmonary symptoms which may make carcinoma probable. One must not overlook similar symptomatology in those under forty that lung cancer may be present. And again, the symptoms and signs of distant metastases should be considered with the possibility that the primary tumor may exist in the lung. As clinicians, we are interested in the controversies of pathologists and research workers concerning morphological changes of tissues, primarily bronchial epithelium, and until this aspect is settled perhaps pathologists can come to some better understanding of histological classification. One cannot emphasize too strongly the greater need for early bronchoscopic examination and measures to be taken for biopsy of a lymph-node, early examination for cancer tissue or cells in pleural fluid, sputum and from lung puncture. Lastly, *x*-ray examination should be complete, thorough and repeated, especially if a suspicion exists. The therapeutic outlook is by no means hopeless.

Chest surgeons today believe that lobectomy is inadequate and that the best results are obtained by a total pneumonectomy. Up to 1939, eighty-six pneumonectomies are recorded in the literature, resulting in thirty-one recoveries and fifty-five deaths, a mortality rate of 63.9 per cent.[10] Some statistics of the later cases up to 1939 are as follows: Graham, a total of four cases, three deaths and one recovery, one patient living six years; Freelander, a total of five cases, with four deaths; one patient living three years; Overholt, a total of eleven cases with three deaths; 2 patients living five years, one patient living four years and five living one year; Edwards, five cases, one death and four recoveries; Churchill, five cases, three recoveries, two deaths, one patient living over five years and two living over three years; Ochsner, DeBakey report nine cases, three recoveries and six deaths, one patient living three years and 2 living one year.[10] Head of Chicago reports one pneumonectomy patient living one year and one lobectomy patient living two years.[16] Leddy and Moersch report a series of 125 patients treated with roentgen therapy and another group of 125 untreated.[2] All were proved cases of bronchogenic carcinoma. Of the 125 patients treated by roentgen therapy, twenty-five are living over a period from twelve to 146 months. Of the twenty-five living patients, eight cases of adenocarcinoma were found as follows: one in the trachea, one in the left upper lobe and two each in the right main bronchus, the right middle lobe and the right lower lobe, respectively. These tumors are the so-called adenomas of the bronchi which has caused considerable controversy as to their malignancy. Jackson in a recent lecture described these tumors of the bronchi which he considered as benign adenoma.[17] Recent bold advances in surgery and possibly greater improvement in roentgen irradiation offer for the future a brighter outlook in the cure and alleviation of this serious disease.

The writers wish to express their thanks to Drs. H. C. Strunk, Jacob Myers, the late S. C. Robinson, L. J. Brody, F. F. Maple, W. P. Curtis, and other members of the Woodlawn Hospital staff for use of their material and kind assistance.

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To the operating surgeon the situation of the thyroid gland is of prime interest. The attachment is so intimate that when the larynx rises in the act of deglutition the thyroid gland follows. Yet there is a layer of connective tissue lying between the thyroid gland and the larynx sufficient to make it possible to dissect the former from the latter without the least danger of injury to either.

PATHOLOGY OF APPENDICEAL STUMP WITH SUGGESTIONS FOR PROPHYLAXIS

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ALTHOUGH the prime object of this article is to report specific cases of pathology of the stump and to suggest prophylactic measures against such occurrence, I should like to enumerate the historical and controversial facts connected with the management of the appendiceal stump.

Historical. The early operations consisted in mere ligation of the stump. Krönlein, in 1886, advocated simple ligation. Treeves, in 1888, sutured the stump which he covered with three Lembert sutures. Senn, in 1889, suggested inversion of the stump. Dawbarn, in 1895, invaginated the stump without ligation. Fowler made a peritoneal cuff for the stump. Lillienthal, in 1903, recommended simple ligation. Seelig, in 1904, likewise recommended simple ligation. Alton Ochsner, in 1939, suggested inversion without ligation, insuring against hemorrhage by a hemostatic purse-string suture.

METHODS IN THE MANAGEMENT OF APPENDICEAL STUMP

A. Simple Ligation without Inversion: Arguments in Its Favor. It was found that simple ligation is all that is necessary in most cases. In an analysis of 1,000 cases by J. F. Baldwin[1] this method was effective. This procedure brings about good hemostasis. There is no infection, if the stump is properly cauterized (Seelig). Maloney[2] did not find either ileus or adhesions among 3,500 cases in which simple ligation was practiced.

Arguments against This Practice. If the ligature should slip, there is the possibility of leakage with its consequences. Edebohls found in several instances infection originating in the ligated stump. Ligation resulted in fecal fistula in several instances. Some observed postoperative adhesions, intestinal obstruction, blowout and sinus formation.

B. Ligation of Stump Plus Inversion: Arguments in Its Favor. A large number of clinical recoveries indicate that the method is safe. It is the method *en vogue* with the majority of American surgeons.

Arguments against It. Since the cecal wall is only $\frac{1}{16}$ inch thick, it is possible for the needle to penetrate the wall and reach the lumen, thus infecting the suture. The suture may interfere with the blood supply. Lexer observed cases of intestinal obstruction following this technic. Kohler found postoperative adhesions at the site of inversion. Abscess in the wall of cecum was found by Bogetti and Robertson, pathologist of the Mayo Clinic. Riedel noticed ulceration in the wall of cecum. Some cases resulted in fecal fistula. Many cases exhibited areas of inflammation of the cecal wall. Maloney found foreign body tumor in the inversion area. Cecal diverticuli were found by Bunto (three cases) and by J. Shelton Horsley. Ortner, taking *x*-rays after appendectomy found that the barium appeared as a ring around the stump. Chas. H. Mayo,[3] in 1934, attempted to summarize the whole situation and gave four reasons against this practice: (1) Robertson, pathologist of the Mayo Clinic, found at postmortem examinations pus pockets in the area of the inverted stump as late as twenty-one days postoperatively; (2) purse-string suture was invariably infected; (3) this procedure lengthens convalescence, and (4) he found no occasion to regret.

C. Inversion of Stump without Ligation: Arguments in Its Favor. No dead space is

formed. There is chance for drainage of infected material in lumen of the bowel. Bürkle-de-le-Camp, reporting on 3,200 cases from Lexer's clinic found no postoperative necrosis, abscess, fecal fistula or hemorrhage. Alton Ochsner[4] inverts the stump without ligation, but insures hemostasis by inserting a loop suture around the meso-appendix attachment to the colon, and by a purse-string suture in the cecum which includes any branch of the appendiceal artery. There is no chance for infection because the stump is inverted in the lumen instead of the cecal wall.

Arguments against Its Use. The stump may open before inversion is completed. The purse-string suture may become contaminated. There is the possibility of hemorrhage. Fowler[5] observed an artery running longitudinally within the wall of the appendix, which is not tied in this procedure.

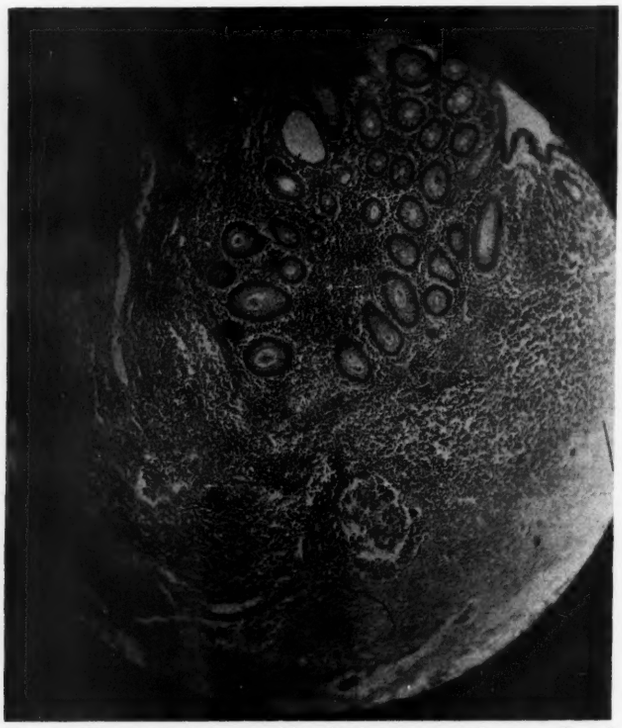

Fig. 1. Shows the average histologic picture of appendiceal stump from cadavers which retains most of the histologic features of an appendix and is easily recognizable as such.

CASE REPORTS

Case I. *Peritonitis from Rupture of Old, Infected Stump.* I am enabled to report this case through the courtesy of Dr. F. M. Sylvester, Oak Park, Illinois.

The patient was operated upon two years before for acute appendicitis. She made an uneventful recovery but exhibited after the operation a symptom complex which was suspected to be due to a duodenal ulcer for which she received medical treatment. When seen by Dr. Sylvester, two years after the original appendectomy, she had a stormy attack of severe abdominal pain referred chiefly to McBurney's zone. There was localized tenderness and temperature of 101°F. Because of the previous history of duodenal ulcer and in the absence of the appendix, Dr. Sylvester thought that the clinical picture may be explained on the basis of ruptured duodenal ulcer. The doctor made an S-shaped incision extending upward toward the ribs and downward toward McBurney's zone. To the great surprise of the surgeon, he found that the patient had a diffuse peritonitis due to infection and rupture of an old appendiceal stump. The patient was adequately drained, but four days later she died.

Final Diagnosis: Peritonitis due to infection and rupture of an old appendiceal stump.

Case II. *Large Mucocele in Cecal Wall, Originating in Old Appendiceal Stump.* This

male patient, age fifty, had an appendectomy performed ten years before entering the hospital for the present operation. He was free from abdominal symptoms until three years ago when he noticed a swelling of the right groin, which was diagnosed inguinal hernia. From time to time he had pains in the groin referred to the abdomen but never had an acute abdominal complex. He entered the Mt. Sinai Hospital, Chicago, for the repair of an inguinal hernia.

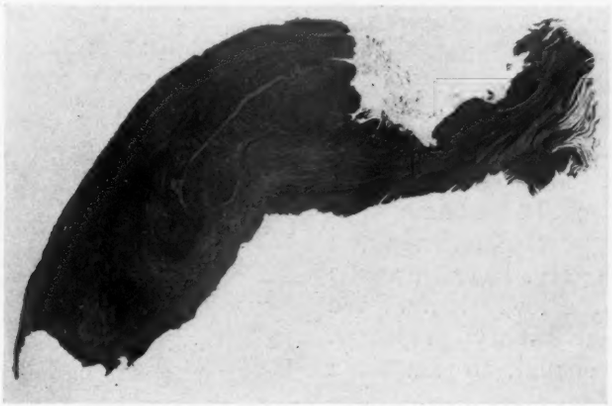

Fig. 2. Shows the continuity of the lumen of the appendix with that of the cecum.

Examination was essentially negative, except for some mental incoherence and evidence of premature senility with intellectual confusion. Physical examination revealed a white male with no particular physical defects or handicaps, except a large right inguinal hernia. The size of the mass did not conform to the physical characteristics of either direct or indirect inguinal hernia. The mass was bulky, had an irregular contour, and was reducible by a sort of invagination of the lower abdominal segment. The inguinal ring was somewhat tender to pressure, the tenderness extending in the right iliac fossa where a mass was felt which could not be definitely diagnosed.

The operation revealed a right inguinal hernia of the sliding type, the outer aspect of the cecum being a part of the parietal peritoneum. Externally to the cecum, but closely connected with it, there was a mass, soft in consistency and shaped like an adult testicle. This mass could not be separated from the cecum and was finally removed. One of the assistants who was not sufficiently familiar with the case thought that we were dealing with an undescended testicle, a part of a sliding hernia.

The pathologic report elucidated the situation and stated that the mass was a mucocele which originated in an old appendiceal stump.

Pathological examination revealed the following: The specimen consists of a hernial sac measuring about 100 by 90 mm. and up to 4 mm. in thickness. The inner surface is grayish-pink and shows trabeculations. The outer surface shows a moderate amount of connective tissue.

The specimen is a tensely filled sac measuring approximately 40 by 30 by 30 mm., the contents of which are a viscid, jelly-like fluid with some fat tissue suspended in it. In the wall there is present a node measuring 15 mm. in its largest diameter, which has on secretion surface a grayish-white appearance. In another area there is present a small node which has a brown and hemorrhagic appearance. The inner surface of the sac is hemorrhagic with yellowish-brown deposits.

The microscopic report was as follows: Sections show in areas a dense connective tissue mixed with a pale blue, loose and edematous material containing fibroblasts and a few star-shaped cells in addition to many capillaries and blood vessels which are distended with blood. Old blood pigment and infiltrations with lymphocytes, plasma cells, neutrophilic and eosinophilic leucocytes are present. Large and small calcified areas are present, of nondescript morphology, some of them surrounded by multinucleated foreign body giant cells. In areas the surface is lined with a tall, columnar epithelium with basal nuclei and a very abundant clear cytoplasm. In one area embedded in a very edematous connective tissue, which resembles somewhat the above described mucinous tissue, is a lumen surrounded by

glandular structures and lined by a tall columnar epithelium with lymph follicles and germinal centers. It has the appearance of the appendix.

Diagnosis: Hernial sac with a chronically inflamed appendiceal mucocele. Chronic foreign body type inflammation.

Case III. *Granuloma in Cecal Wall at Site of Old Appendiceal Stump.* (Referred by Dr. Estelle Anis, Chicago.) The patient was a housewife, age twenty-two. She had an appendectomy performed two years previously and made an uneventful recovery. Ever since she complained of pain in the lower half of the abdomen with some vague urinary symptoms. The pain was intense enough to consult a physician and seek relief at various times during the past two years.

Physical examination was practically negative except for definite tenderness in McBurney's zone, especially on deep pressure. Although the diagnosis was not definite, the patient was persistent in her complaint and was anxious to undergo an exploratory operation. At the time of the operation the findings were as follows: A knob, the size of a large cherry, was present in the cecum at the site of the inversion of the appendiceal stump in the wall of the cecum. Several omental flaps were pulling on the peritoneum, one of them lifting up the bladder. There was considerable mesenteric adenitis. There was also an imperfect closure of the fascia. The omental flaps were separated from the peritoneum and bladder. The knob in the cecum was removed, which required the removal of a segment of the cecum. This was done by applying a light stomach clamp upon the cecum and the defect was repaired with two rows of suture. The peritoneum was closed by making an ectropium, according to the suggestions of J. B. Murphy, in order to prevent adhesions.

The laboratory findings were as follows: There was a fibrous nodule which bulges on to a pink-tan mucosal surface. The latter is speckled with hemorrhage in its lymph follicles.

In paraffin sections stained with hematoxylin and eosin the tissue in the appendiceal stump is typical of appendix and provided with a lining in which there are large mucous glands and large lymph follicles with distinct germinal centers. About one-third of the muscle layers are replaced by fat and contain lymphocytic infiltration sparsely. The appendix-like material covers everything and rises as a short nubbin above the surrounding cecal tissue. Sections in two planes reveal the same changes.

Diagnosis: Appendix stump.

HISTOLOGIC SECTIONS OF APPENDICEAL STUMP FROM CADAVERS

It occurred to me that if the stump retained the histologic pattern of the average appendix, showing the presence of follicles, mucosal pattern and, above all, intact blood vessels, the stump was still viable. In other words, the individual was the possessor of a short appendiceal stump potentially capable of pathology. With this end in view, I have collected a series of appendiceal stumps from fresh cadavers who had appendectomies performed at various times in the past. This was made possible by the help and courtesy of Dr. Alexander Ragins of the Pathologic Department of the Cook County Hospital, Chicago. His summary account of the histologic findings of these slides are as follows:

Practically all slides show an early recognizable appendiceal stump represented by mucosal pattern, lymphoid follicles, blood vessels. The muscular coat most often is replaced by scar tissue. The proximal portion of the stump is seen merging into the cecal mucosa. In some instances the stump measures 1 to 2 cm. in length, while in others in which the appendiceal stump was very short, scar tissue replaced the short stump and in some instances exerts a pull upon the cecum, causing a slight, small, diverticulum. In short, most cadavers still possessed an appendiceal stump, which had all the earmarks of an appendix.

The following illustrations are typical of many appendiceal stumps in cadavers, and Dr. A. Ragins has selected two typical patterns.

SUGGESTIONS OF TECHNIC

Whatever technical method may be used in appendectomy, it does not seem entirely logical to leave behind a stump which is a part of a pathologic organ. On the face of

it, it would seem more logical and thorough to remove the entire appendix. Dr. Joseph Price, of Philadelphia, once stated that he who leaves behind one-eighth of an inch of appendiceal stump has performed only seven-eighths of the operation. There is no doubt that an ideal state of affairs would call for a total and complete appendectomy. The fact that the surgical profession obtained clinical recoveries even though they left behind a stump, explains the lack of desire or incentive for changing what seems to be a satisfactory procedure.

John B. Deaver,[6] evidently mindful of this inadequate surgery, removed the appendix by extirpating a small segment of the cecum which he held between the thumb and index finger, after which the defect was repaired by two rows of sutures. This method was thorough enough, but could hardly be recommended to the "occasional operator," as the cecum could slip between the surgeon's fingers, thus soiling the field. He eventually abandoned this procedure and returned to the prevailing methods of dealing with the stump.

Zeller[7] and Haggard[8] removed the appendix by cutting it flush with the cecum and subsequently repaired the defect in the bowel.

If one should have an inclination in performing a total appendectomy, the following suggestions are made:

The base of the appendix does not terminate abruptly at the cecum but often seems to run intramurally, thus deceiving the surgeon. I have followed the plan of dividing the peritoneal films which creep up upon the base of the appendix, and to my great surprise I have frequently found that I could obtain another half, three-quarters or even an inch of the appendix which I had not suspected. This procedure definitely brings out more of the appendix. If one wishes to go beyond this, one could apply a short, curved, rubber-covered intestinal clamp upon the cecum, thus removing the entire appendix and a small segment of the cecal wall. The protruding tissue beyond the clamp may be cut away with curved scissors, the raw surface touched with iodine or cautery and finally the defect in the bowel closed according to the principles of intestinal surgery. If such procedure is used, it is advisable for the operating surgeon to change his gloves at this point and ask the assistants to wash their gloves thoroughly in running sterile water.

I fully appreciate that this procedure transforms a comparatively simple technic into a more difficult and dangerous one, especially in the hands of the less experienced. Yet, I cannot help believe that the diseased appendix might be removed *in toto*, thus avoiding all the criticisms and occasional mishaps connected with leaving an appendiceal stump.

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THE EMERGENCY CONTROL OF POSTPARTUM HEMORRHAGE*

EXPERIENCE WITH A SUPPLEMENTARY TECHNIC

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THIS communication is concerned only with bleeding from the relaxed uterus immediately after delivery and omits any consideration of bleeding from cervical or vaginal tears. Since postpartum hemorrhage is still one of the principal causes of death after childbirth, any effective method of preventing or controlling it is decidedly in order. Modern obstetrics sometimes seems complicated. It is, therefore, necessary in this report to show that the procedure advocated is safe and useful.

Following separation of the placenta, control of bleeding from the uterus is effected almost entirely by its contraction, thus producing a literal strangulation of the interspersed sinuses. Coagulation of the blood is of little primary importance as a patient can become exsanguinated too quickly.

The advent of pain-relieving agents during labor, often followed by anesthesia in which the anesthetic may be of a relaxing type (ether), has brought about a situation which requires new methods of treatment. This is especially true when dealing with a thinned-out, overdistended uterus, the condition being aggravated by drugs and anesthetics. Even following delivery in which exhaustion is not a factor, uterine tone may be so impaired that, while it is sufficient to separate the placenta partially or completely, it is not sufficient to clamp down the uterus immediately in the vise-like manner so desirable. A moderate delay in contracting may permit a large amount of blood to escape.

Previously the time honored method of waiting twenty minutes for the separation and expulsion of the placenta was good treatment and gave satisfactory results. Over twenty years ago one of the authors (R. A. W.), in a study involving over 2,000 deliveries in which no anesthetics were used, found only one instance of severe postpartum hemorrhage. Conversely, it is our opinion that this conservative method of treatment is often inadequate in modern obstetrical practice.

The late Dr. Ralph Pomeroy taught that each mother has in her blood under normal conditions ecbolic substances sufficient in amount to produce the desired uterine contraction. He also showed that it is not difficult to neutralize these substances by fatigue, drugs and anesthetics, and claimed that the matter was largely quantitative. For example, uterine contractions may be weakened by morphine and ether, or a contracting uterus may be transformed into a soft, jelly-like bag by deep anesthesia previous to version. As far as possible this relaxation of the uterus should be prevented.

We give as a prophylactic measure an oxytoxic substance immediately after the delivery of the baby in order to anticipate and prevent any relaxation and at the same time to hasten the separation and expulsion of the placenta. In this institution for more than fifteen years we have routinely administered pituitrin intramuscularly immediately after the birth of the baby. In only a few cases has the placenta been retained,

* From the Department of Obstetrics and Gynecology, Methodist Hospital, Brooklyn, New York. Read before the Obstetrical Society of Philadelphia, October 3, 1940.

and on no occasion was difficulty experienced in expressing it under a mild degree of anesthesia. We believe this mild complication is unduly feared and should not be allowed to counterbalance the beneficial effects of the early administration of this drug. These effects are so striking that no member of our staff would wish to return to the method of giving an oxytoxic only after the delivery of the placenta.

It is not our intention to discuss the relative value of uterine and vaginal packs. The former may be dangerous, the latter deceptive, and neither will control bleeding without firm uterine contraction.

To produce this contraction additional intramuscular injections of pituitrin or ergot preparations are effective in most cases when used in conjunction with uterine massage and elevation of the organ well out of the pelvis. It should be borne in mind, however, that if bleeding is profuse many minutes may elapse between intramuscular injection and uterine response. If bleeding is serious, a very rapid contraction can be obtained by the intravenous injection of pituitary or ergot preparations. In certain institutions this method is used routinely, but it is not yet certain that it is free from danger, nor is it always available due to lack of personnel or failure of technic.

Many operators inject pituitrin directly into the uterine wall at cesarean section. We have found this method satisfactory. The resulting contraction is rapid and marked and only a few minims need be used to prevent bleeding. At the point of injection there is immediate blanching which spreads in a few seconds in all directions and the contraction may even make suturing of the uterine incision difficult by reason of its hardening and thickening. This clearly shows that excessive bleeding can be controlled if the necessary drugs are brought to the uterus in sufficient concentration and without loss of time. Certain English writers advocate the injection of pituitrin into the uterus through the abdominal wall. This appears radical and yet is claimed to be relatively safe.

TECHNIC

As there are some desperate situations in which the direct injection of an oxytoxic drug into the uterus may be desirable, we have tested a method for introducing it in a somewhat different manner. Our technic is as follows: The cervix is either lightly grasped by the anterior lip with a smooth sponge forceps and pulled down, or it is pushed down by fundal pressure into the lower part of the vagina until it is well visualized. Using a small needle (22 or 24 gauge), 1 cc. of pituitrin is injected through the anterior wall of the cervix directly into the lower uterine segment. We have found that the injection should not be made into the edematous anterior cervical lip but must be made high in the anterior fornix through the cervix directly into the uterine wall to the depth of 2 to 3 cm.

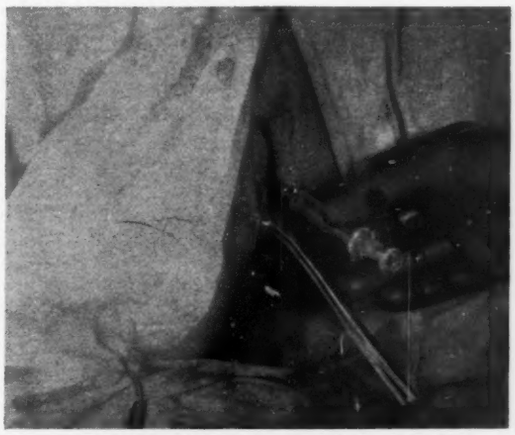

Fig. 1. Technic of injection. Cervix is pulled down to introitus and needle enters lower uterine segment through anterior cervical wall.

To prove the effectiveness of such a procedure we now present a series of cases in which this method alone was used. One hundred unselected ward patients were tested. A delivery table was equipped with a Pastore blood-measuring apparatus which permitted an accurate mensuration of the blood loss during all stages of the delivery but with a trap so arranged to permit the spill of liquor amnii. No oxytoxic was given until after the delivery of the placenta when the transcervical injection of 1 cc. of pituitrin was made. The

blood loss was measured from the time of the perineal incision until the time of the injection. An assistant's hand was placed on the fundus to determine the time when the firm uterine contraction was established. The blood loss from the time of the injection until the time the patient left the table was also recorded, the sum during all stages being the total measured loss. After the patient was placed in bed, an intramuscular injection of an ergot preparation was given for its prolonged effect.

Of the one hundred patients comprising this series, forty-three were primipara, fifty-seven multipara, the ages varying from seventeen to forty-three years with an average age of 26.4 years. The average duration of labor was 14.9 hours for the former, 9.7 hours for the latter. There are an insufficient number of cases to correlate the duration of labor with the incidence of postpartum hemorrhage. The method of delivery is shown in Table I.

TABLE I

Method of Delivery	No. of Cases	Percentage
Spontaneous	62	62
Prophylactic forceps	24	24
Low forceps	6	6
Mid forceps	2	2
Breech	6	6

There is no direct relationship between this and the occurrence of bleeding since nine of the fourteen cases of hemorrhage followed spontaneous deliveries. We know that hard instrumental deliveries, versions, extractions, etc., all produce postpartum hemorrhage not only because of frequent vaginal and cervical lacerations, but also because these procedures follow hard labors in tired, often deeply anesthetized patients who may have had an inordinate amount of analgesia. Incidentally, in thirty-three of our cases we were able to measure the blood loss from the episiotomies alone by plugging the upper vagina with gauze. It is of interest to note that the average blood loss was over 100 cc. and approached 500 cc. occasionally. The slow but steady flow of blood from perineal vessels cannot be ignored.

TABLE II

Total number of episiotomies	67
Number of second degree lacerations	7
Number of first degree lacerations	10
Measured blood loss from 33 episiotomies	25 to 500 cc., average 105 cc.

For the purposes of this study the routine use of pituitrin immediately after the birth of the baby was omitted. We anticipated and found an increase not only in the incidence but particularly in the severity of postpartum hemorrhages. Before installing a blood-measuring apparatus, estimated immediate postpartum hemorrhages of 500 cc. or more appeared in 4 to 6 per cent of our deliveries. The actual mensuration of the blood loss (Table III) proved how easy it is to underestimate this.

TABLE III

	Oxytoxic after Second Stage	Oxytoxic after Third Stage
Total number of cases	100	100
Average blood loss	259 cc.	310.6 cc.
Total Number of Hemorrhages	No. Per Cent	No. Per Cent
500 cc. or over	8 or 8	14 or 14
600 cc. or over	3 or 3	11 or 11
1,000 cc. or over	0 or 0	4 or 4
Average duration of third stage.	1 to 22 min. 6.5 min.	1 to 33 min. 10.0 min.

Using the prophylactic injection of pituitrin and measuring the blood loss, postpartum hemorrhage occurred in 8 per cent of one hundred patients, three of whom bled 600 cc. or more. By omitting this prophylactic oxytoxic, we have proved our clinical impression, finding the incidence of postpartum hemorrhage of 500 cc.

now reaching 14 per cent, four patients losing as much as 1,000 cc. of blood. Notice that not only was the incidence of hemorrhage nearly doubled but large hemorrhages predominated. The duration of the third stage varied from one to twenty-two minutes with an average of 6.5 minutes when pituitrin was administered early. Without it the third stage lasted from one to thirty-three minutes with an average duration of 10.0 minutes. These figures undoubtedly prove the value of the use of pituitrin as soon as the baby is born.

A general anesthetic was used for 97 per cent of the deliveries and this point is worth noting; the average duration of the anesthetic in fourteen patients who had hemorrhages was 35.3 minutes while for a total of ninety-seven patients it was only 25.7 minutes.

Having produced relaxed uteri which bled profusely, we were now dependent upon only one method for controlling them, namely, the direct, vaginal, transcervical injection of pituitrin into the lower uterine segment after the placenta had been delivered. Our results are tabulated in Table IV.

Table IV

Average blood loss before injection	237 cc.
Average blood loss after injection	95.3 cc.

The average blood loss before injection was 237 cc. After injection the average blood loss was only 95.3 cc. This means that uteri relaxed by analgesia, anesthesia and often fatigue can be injected directly with a drug, resulting in an average blood loss of less than 100 cc. following the injection. The speed and effectiveness of this method of administration is shown by the figures in Table V.

Table V

Interval between injection and firm uterine contraction	46 cases timed 10 to 660 seconds
Average	84 seconds

In forty-six cases that were timed it was possible for an assistant to palpate the uterine contraction after injection and record the time necessary for its production. The average interval between injection and a firm uterine contraction was eighty-four seconds. Thus we have a method which, properly executed, will produce a firm contraction of the uterus within a minute and one third even in tired, relaxed organs.

The method is not completely perfect. The response was excellent in ninety-three instances and bleeding after injection was minimal. (Table VI.) Seven of the fourteen cases in which hemorrhage occurred responded immediately. Note that two of these patients bled 900 cc. and 1,100 cc., respectively, before injection; formidable hemorrhages were immediately controlled by this method, there being no blood loss following injection. Of the remaining seven in which the response was poor, the injection was repeated in three with immediate response in two of these. This leaves only five cases in which the response was poor immediately or following second injection and only two of these bled as much as 500 cc. after injection. Of the entire one hundred patients there were only twelve who

Table VI

SUMMARY OF FOURTEEN CASES OF HEMORRHAGES

Case No.	Blood Loss before Injection: cc.	Blood Loss after Injection: cc.	Total Loss: cc.	Interval before Contraction
1. 21511	500	300	800	10 sec.
2. 21426	440 plus 40 from vagina	20	500	300 sec.
3. 16856B	900 plus 300 from vagina	0	1200	60 sec.
4. 16915B	1100	0	1100	60 sec.
5. 21549	350 plus 75 from vagina	100	525	60 sec.
6. 21585	500	200	700	60 sec.
7. 15513	600	0	600	10 sec.
8. 21547	250 before first 200 before second	50	500	Good; relaxed in 7 min., repeated
9. 21518	300 before first 200 before second	200	700	Boggy until repeated
10. 21463	300 before first 200 before second	700	1200	Poor
11. 21563	500	250	750	480 sec.
12. 15823	550 plus 250 from vagina	250	1000	600 sec.
13. 9581C	300	300	600	60 sec.
14. 19773A	250	500 (mostly from vagina)	750	12 sec.

bled 200 cc. or more after injection or injections. We believe that these failures are technical failures and this impression is strengthened in those instances in which the uterus failing to respond to the first, probably incorrect injection, reacted so rapidly to the second. Six different members of the house staff used this method and few technical errors show how quickly it can be mastered. That there was not more actual blood loss following these injections is surprising for a uterus relaxed and distended with blood will necessarily expell 200 to 300 cc. when it contracts.

TABLE VII

Total number of cases	100
Gross morbidity	4 or 4%
Corrected morbidity	3 or 3%
Maternal mortality	0
Fetal mortality	0

We believe that this method is safe. Of the one hundred patients in whom it was used only four had a morbid* puerperal course, one of these being caused by mastitis. This gives a gross morbidity rate of 4 per cent and a corrected morbidity of 3 per cent which compares favorably with the hospital morbidity rate of 2.5 per cent. There were no fetal or maternal deaths. (Table VII.)

In no instance was the patient morbid for more than three days. It does not appear that this method increased the danger to the patient from infection. When it was first used, we were fearful of puncturing large vessels. If such has been the case, we have not been able to detect it nor find the slightest untoward effect.

* Standard of morbidity—single rise to 100.4°F. in two consecutive twenty-four-hour periods excluding the first.

CONCLUSIONS

1. Certain fundamental considerations of the cause and treatment of postpartum hemorrhage are discussed.

2. Two series of cases are compared showing that the prophylactic injection of pituitrin after the second stage of labor decreases the incidence of postpartum hemorrhage by nearly 50 per cent, almost eliminates the very severe hemorrhages and decreases the duration of the third stage.

3. An infrequently used method of controlling postpartum hemorrhage has been tested, i.e., direct transcervical injection of pituitrin into the lower uterine segment.

4. In one hundred patients the average blood loss following such injection was 95 cc.

5. Firm uterine contractions were produced after an average of eighty-four seconds in forty-six cases that were timed.

6. This method seems safe, no ill effects having been found, and there has been no increase in the morbidity rate.

THE TREATMENT OF PELVIC INFECTION BY IONTOPHORESIS OF A CHOLINE COMPOUND

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THE operative treatment of chronic pelvic inflammatory disease is unsatisfactory. Half-way measures selected because of the desire to conserve essential function are inadequate and usually result in the need for further surgery. It therefore is generally admitted that nonoperative or conservative treatment should be given an extensive trial before the patient is subjected to operative intervention and when this fails, the operation should be a radical one. For this reason, any therapy which may improve the results of conservative treatment should be of value. Conservative treatment, as we understand it, may be discussed under four headings: rest, measures to increase general resistance to infection, chemotherapy and, finally, the induction of pelvic hyperemia.

The value of rest in aiding the subsidence of infection is well recognized. This includes not only rest from physical exertion, but rest from sexual stimulation and intercourse. Unfortunately, the economic status of many patients prevents the discontinuance of their usual occupations.

As for the value of measures designed to raise the resistance of the patient to infection, there appears to be no question but that repeated small blood transfusions are beneficial. This is especially true if the inflammatory condition is complicated by anemia. Such treatment, however, requires hospitalization, is costly, and even when followed faithfully cannot be expected to bring about complete cure. In this connection also may be considered the use of foreign protein therapy which at one time was a favored method of treatment but has since been largely discarded.

The advent of chemotherapy was hailed as the treatment likely to answer the problem but unfortunately the results have been disappointing. In the treatment of the initial infection and acute exacerbations of chronic infections chemotherapy is of great value, especially when the gonococcus is the etiologic agent. In the subacute and chronic forms in which inflammatory tuboovarian masses or cellulitic exudate can be palpated treatment by sulfanilamide is generally disappointing. Our experience (1) in a group of seventy-four hospitalized patients with severe chronic and subacute infection has shown that the use of sulfanilamide in such cases is followed by very little improvement over the results obtained by prolonged rest in bed. We believe, however, that chemotherapy is of value in (a) primary gonococcal infections, (b) if the gonococus can be demonstrated in acute exacerbation of a chronic infection, and (c) if the Streptococcus hemolyticus is the etiologic agent. More recently we have been using sulfathiazole, a sulfonamide with a wider range of action against the various pathogenic bacteria causing pelvic infection. It is yet too early to evaluate our results.

The induction of pelvic hyperemia in the treatment of the chronic and subacute forms of pelvic infection remains one of our valued methods for treating these disorders. The hot douche, Elliot treatment and diathermy are examples of methods long since used to produce pelvic hyperemia. In pelvic iontophoresis of a choline compound, however, the most intense degrees and prolonged durations of pelvic hyperemia can be brought about. When

pelvic hyperemia is indicated, pelvic iontophoresis promises to be the method of choice.

The use of iontophoresis of medicaments in the treatment of localized infections is not new, and there is definite laboratory evidence to indicate that when mecholyl chloride, a choline compound, is used, the absorption of the drug will produce active hyperemia. Jacoby[2,3] has been principally responsible for awakening interest in the use of this therapy for pelvic infection. We have used pelvic iontophoresis of a choline compound in the treatment of the severe forms of subacute and chronic pelvic infection and have already reported our results.[4,5] While this method of treatment is in no sense a cure-all, it has a definite place in the treatment of pelvic infection. After briefly describing the technic of treatment, a summary of our results and the types of pelvic infection responding best to the therapy will be presented. (Fig. 1.)

TECHNIC

The technic is quite simple and may be used as an office procedure for patients with pelvic inflammatory disease. The following equipment is necessary:

1. An apparatus capable of delivering a direct current of 15 to 20 milliamperes.
2. A vaginal electrode consisting of a metal rod surrounded by insulating material and terminating at one end in a small mobile crosspiece of metal.
3. Twenty cc. of ½ or 1 per cent mecholyl chloride (acetyl-beta-methyl-choline chloride) and a quantity of gauze sufficient to be soaked to about saturation.
4. An abdominal galvanic pad 6 by 8 inches.
5. A bivalve vaginal speculum and uterine dressing forceps.

The procedure is as follows: Before beginning treatment the abdominal pad is placed in warm tap water. Occasionally, difficulty in raising the milliamperage is due to insufficient soaking of the pad. With the patient in the lithotomy position, the speculum is introduced, the cervix exposed and all secretion is wiped away so that the drug may come into intimate contact with the vaginal mucosa. The gauze soaked with the solution of the drug is placed around the vaginal end of the electrode and introduced into the vault of the vagina. The small crosspiece of the electrode should be at right angles to the main bar and preferably in the posterior vaginal fornix. The gauze covered electrode is then held firmly against the fornices and the speculum withdrawn. The vaginal electrode is always attached to the positive pole and the current is increased very slowly to 15 or 20 milliamperes. The patient generally experiences a slight local sensation of shock if the current is increased too quickly. The abdominal pad is held firmly against the skin by a binder or sand bags. A sensation of pricking, burning or sticking due to failure of the pad to make sufficient contact may be eliminated by having the patient make pressure with her hands over the pad. Treatment lasts about twenty minutes, and at its conclusion the current should be decreased gradually otherwise the patient may experience a slight local shocking.

Local effects are rare but such systemic reactions as an increase in the pulse rate, flushing, sweating, lacrimation and salivation are common and result from absorption of the drug. It is desirable to have some systemic effect in order to be certain that absorption of sufficiently active solution of the drug is taking place. Treatments should be given every other day for a period of two to four weeks depending on the response to the therapy.

The following groups of hospitalized patients were studied: (1) fifty-eight patients with severe pelvic infection, thirty-seven having tubo-ovarian and twenty-one cellulitic infections; (2) thirty-nine patients with myomas and clinical evidence of pelvic inflammatory disease, or tumor degeneration, or both.

Our estimation of the value of pelvic iontophoresis is based upon unusually rapid improvement in the clinical and

laboratory findings. Subsidence of fever, pain and abdominal tenderness, diminution in the size of inflammatory masses, and disease, degeneration of myomas, or both. As a result of frequent operation in the latter group, material for pathologic study

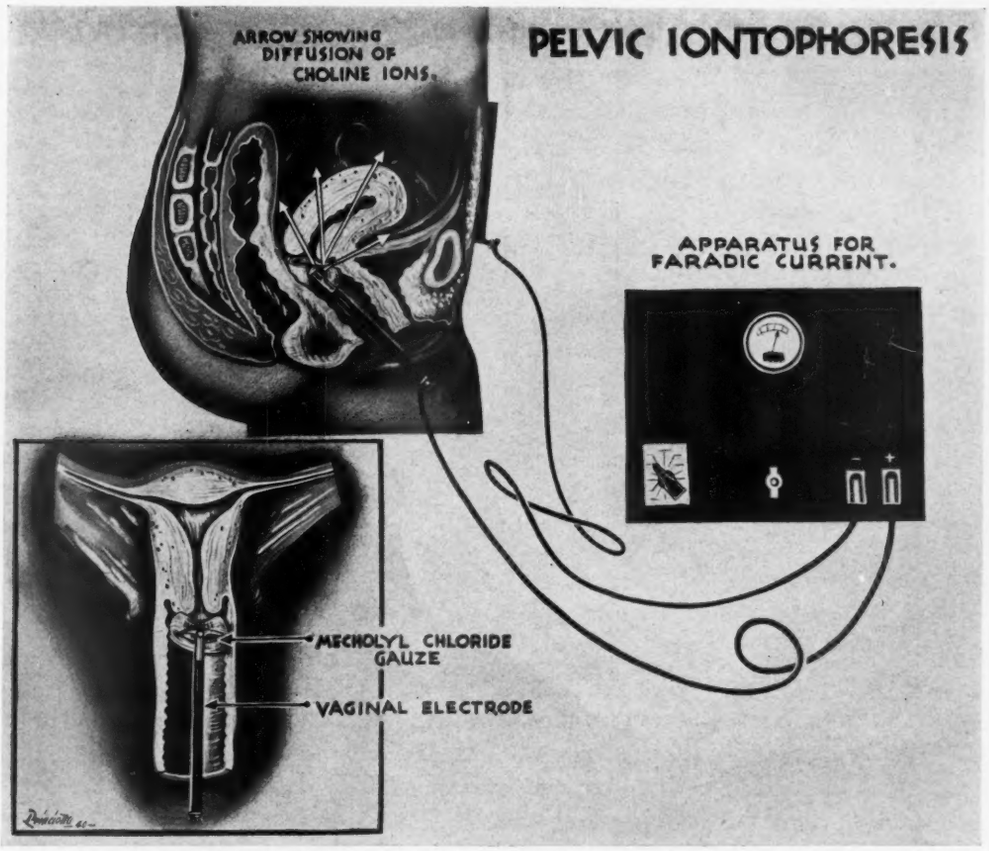

FIG. 1. Diagrammatic illustration of relationships of apparatus and pelvic organs in iontophoresis. (From Gordon, C. A. and Rosenthal, A. H. Studies in pelvic iontophoresis. *Am. J. Obst. & Gynec.*, 41: 237, 1941.)

more favorable leucocyte counts and sedimentation rates have been the criteria of improvement. It is clear, of course, that subacute or chronic pelvic inflammatory disease, whether associated with myomas of the uterus or not, tends to improve on bed rest alone. Observation of more than 500 cases of pelvic infection a year in our wards at the Kings County and Long Island College Hospitals has made us reasonably familiar with what to expect from bed rest, transfusion and supportive therapy.

SUMMARY OF RESULTS

1. Pelvic iontophoresis of a choline compound was given to fifty-eight hospitalized patients with severe pelvic infection and thirty-nine patients with myomas of the uterus associated with pelvic inflammatory disease, degeneration of myomas, or both. As a result of frequent operation in the latter group, material for pathologic study was available in the great majority of cases, thus affording an excellent opportunity for determining the type of pathological condition treated and the effects produced.

2. The results of therapy in tubo-ovarian infections while often good were not sufficiently good to warrant routine use of this method of treatment. It would seem that one cannot hope for resolution of old inflammatory tubo-ovarian masses since fibrosis and multilocular cysts are a prominent part of the pathological condition. It may, however, be given a trial in persistent tubo-ovarian infections which do not respond to other methods of treatment as well as in those patients in whom operative treatment is not indicated.

3. The best response to the therapy was noted in cases of massive cellulitic infection

of recent origin which failed to yield to ordinary treatment. Pelvic iontophoresis is recommended in particular for this type of infection.

4. The preoperative preparation of myomas associated with pelvic inflammatory disease may often be shortened with this method and the operative risk decreased.

5. In cases of myomas complicated by degeneration, iontophoresis had either no effect, or more commonly accelerated the degenerative processes.

6. In cases of myomas in which the differential diagnosis between accompanying infection or degeneration is difficult, the method may aid. It will prevent undue preoperative delay in awaiting for satisfactory laboratory data in the case of degeneration and, on the other hand, will help to avoid the dangers incurred in operating in the presence of pelvic infection.

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The important point in the study of the colloid in normal thyroid glands is that it shows tinctorial changes identical with those seen in cardiotoxic goiters. This suggests that the thyroid need not attain goitrous dimensions in order to affect the heart. There is no other organ of the body which shows such early and extensive degenerative changes as does the thyroid gland.

SURGICAL TREATMENT OF AXILLARY HIDROSADENITIS SUPPURATIVA*

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HIDROSADENITIS suppurativa is a chronic inflammatory disease characterized by the formation of abscesses, sinuses and ulcerations in selected regions such as the axillary, mammary, inguinal, genital and perianal. The disease may be of general involvement with extensive ulceration and undermining of the skin and subcutaneous tissue or limited to one region, commonly the axillae.

The disease has also been described under such titles as abscess or furunculosis of the axillae, the buttocks or the anus, pyoderma, nonspecific granuloma and fistulous disease of the buttocks.

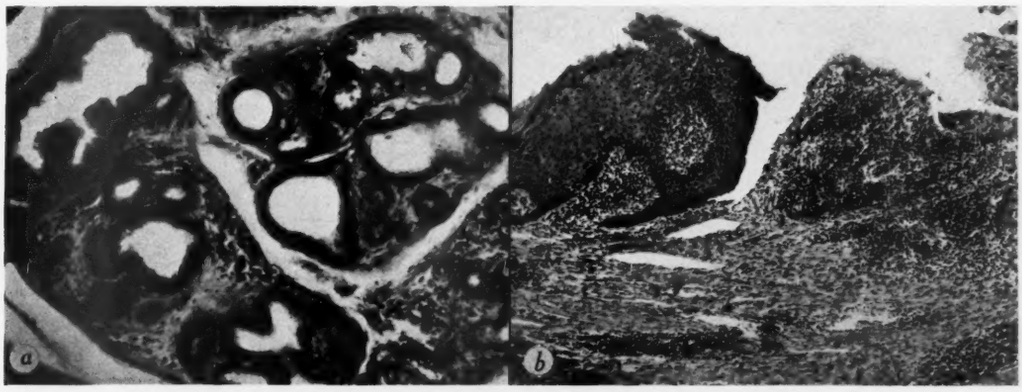

FIG. 1*a*. Inflammatory reaction around apocrine sweat glands; *b*, ulceration of the epidermis.

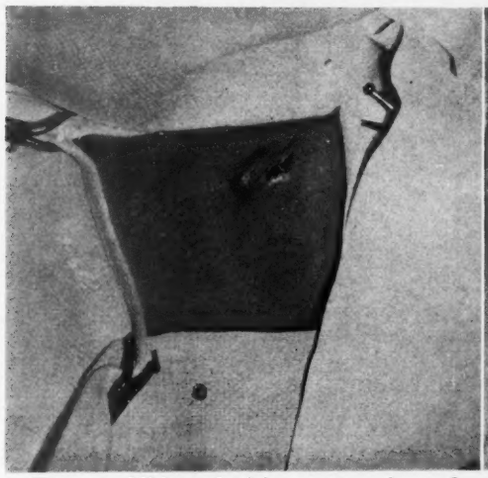

FIG. 2. Hidrosadenitis suppurativa of the right axilla; recurrent type of short duration.

FIG. 3. Extent of excision which includes all the axillary hair-bearing area.

The occurrence of the disease in particular regions is attributed to the presence of a peculiar type of sweat gland. Verneuil,[3,4] who brought the condition to attention in a series of reports between 1854 and 1865,

* Read before the meeting of the Central Surgical Association, Ann Arbor, Michigan, February 28, 1941.

recognized the association of the abscesses with the sweat glands. These peculiar sweat glands, known as apocrine glands, arise

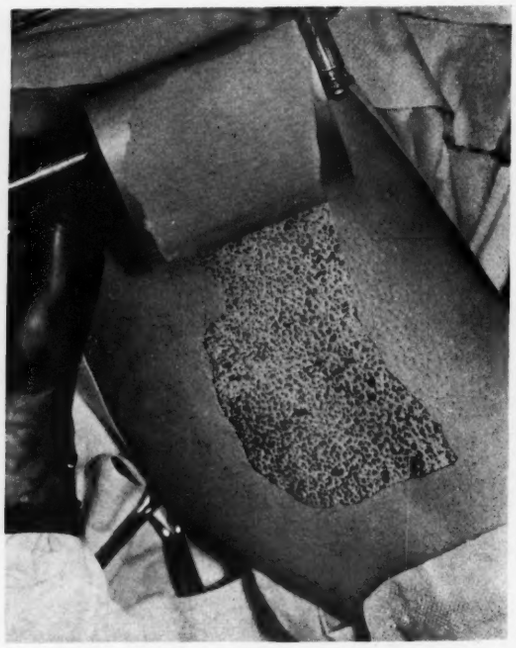

Fig. 4. Removal of skin graft from the thigh which is chosen as the donor, a Paget dermatome being employed.

from the hair follicles instead of from the epidermis and become active at puberty. Their biologic significance was pointed out

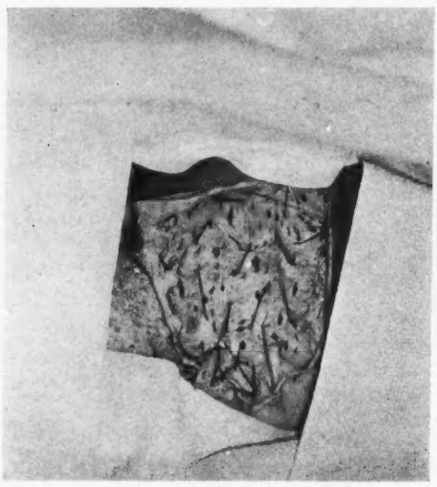

Fig. 5. The graft sutured in position. Multiple perforations of the graft are visible.

by Schiefferdecker in 1922. The apocrine glands are thought to be remnants of the scent glands, which in some animals are associated with sexual attraction. The apocrine glands do not secrete sweat but function by rupture of the cell membrane with extrusion of the cellular protoplasm into ducts which open either directly into

Fig. 6. Postoperative type of dressing employing sea sponge for compression.

the hair follicle or on the epidermis adjacent to the follicle. It is the plugging of these ducts and subsequent infection that lead to formation of abscesses.

The onset of the disease is usually insidious, with a feeling of discomfort, pruritus and burning. With progression of the process, pain develops and a nodule becomes palpable. Frequently this is followed by the appearance of new nodules. Because of the deep-seated infection suppuration is rare and involution may take place. In the more favorable cases the condition will respond to early conservative treatment; however, the process may persist and extend into the deep layers of the subcutaneous tissue with the formation of extensive sinus tracts and of characteristic cord-like elevated bands. This cord-like structure is characteristic of the infection and results from the coalescence of multiple nodules. In the later stages of the disease, in those cases in which the condition has not responded to conservative treatment or in neglected cases, there occur inversion and undermining of the cutaneous margin with destruction and fibrosis of the sub-

cutaneous fat and connective tissue, leaving epithelial bands to connect the sinuses. Extensive ulceration and loss of all the reported the axillae alone were involved. In thirteen of the twenty-two cases the onset was in the axilla.

Fig. 7*a*. Hidrosadenitis suppurativa of the right axilla, an early recurrent type with sinus and scarring present; *b*, appearance of the graft with a complete take two weeks postoperatively.

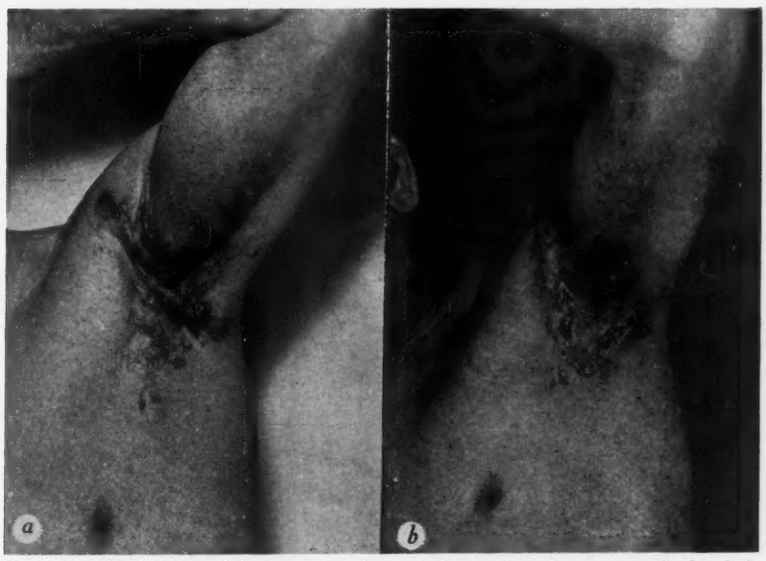

Fig. 8*a*. Hidrosadenitis suppurativa with an involvement of the left axilla of the long-standing type with the characteristic presence of cord-like bands, sinuses, undermining and ulceration; *b*, three weeks after operation showing the extent of the graft with practically a complete take of the graft.

epithelial tissue in the involved area may occur.

In a recent report by Brunsting, of twenty-two cases of hidrosadenitis suppurativa observed at the Mayo Clinic, the distribution was slightly higher in the male sex and the average age was thirty years. In approximately a third of the cases

In the eight cases in which the intradermal tuberculin test was performed the result was negative. The results of inoculation of guinea-pigs were negative in the five cases in which this procedure was employed. Bacteriologic reports in thirteen of the twenty-two cases showed a hemolytic streptococcus of the micro-aerophilic

type in six cases. Staphylococcus aureus and Streptococcus viridans were the most common organisms found.

Fig. 9. Appearance of an axilla one year after excision of an extensive area of involvement with hidrosadenitis suppurativa and immediate skin grafting.

PATHOLOGY

The apocrine sweat glands are characterized microscopically by the presence of two layers of cells, an inner of the cuboidal type, which is the active secretory cell, and an outer flattened type of cell. In the stage of active secretion, these glands exhibit numerous papillary infoldings, whereas in the resting stage the papillary infoldings are absent. The inner layer of cells has a distinctive acidophilic cytoplasm which is somewhat granular. The cytoplasm usually contains hemosiderin and a yellow pigment which probably belongs to the lipochrome group.

In the earlier stages of this disease it is usually possible, histologically, to demonstrate the primary involvement of the apocrine sweat glands. The infection disseminates by means of the lymphatic channels and tissue spaces throughout the cutaneous and subcutaneous tissues until in the later stages the sweat glands are no longer recognizable. The process is associated with the formation of abscesses and as the inflammatory process progresses in one region it tends to heal in another region so that in studying sections from this condition one may find in one region an abscess made up of polymorphonuclear leukocytes and lymphocytes, while in another, granulation tissue, and in still another, fibrosis with very little cellular infiltration. Associated with the abscesses there is frequently ulceration of the surface epithelium with the formation of sinuses. (Fig. 1*a* and *b*.)

TREATMENT

Hidrosadenitis of the axilla, the most common location of the infection, fortunately lends itself to surgical treatment. Surgical treatment is confined to those cases in which the condition primarily does not respond to conservative treatment, to cases of recurrent involvement and to those of long standing which have been neglected.

Special attention should be called to the group of cases of early axillary infection in which the condition does not respond to adequate primary conservative treatment. Surgical treatment should not be delayed too long as there seemingly is a vulnerability to infection of the apocrine glands in other locations. Further, it should be pointed out that after surgical excision of the infected axilla, there is a favorable response in other associated infected regions. This report of the surgical treatment of axillary hidrosadenitis is based on a review of the records of ten cases in which fourteen axillae were treated surgically. The first procedure of excision of the axilla and skin grafting was carried out at the Mayo Clinic in August, 1936. All the patients have shown satisfactory healing and the results have been most gratifying. In one case, however, there was a postoperative complication, a subpectoral abscess, which responded to incision and drainage.

The surgical procedure consists of excision of all the ulcerated or involved regions

of skin and subcutaneous tissue. In cases of minimal involvement the excision should include all the hair-bearing area. The excision is carried out by dissection en bloc and should include any fibrous or inflammatory regions in the fat and connective tissue as well. There is no contraindication to carrying out the procedure in the presence of purulent drainage and performing a skin graft primarily. (Figs. 2 and 3.)

After completion of the excision a split skin graft, preferably removed in one piece, is obtained from a convenient donor area such as the thigh or abdominal wall. The Paget dermatome facilitates the removal of the graft. (Fig. 4.) The graft is well perforated to permit leakage of serum, hematoma or any localized focus of infection. The graft is then sutured into position in its prepared bed; suture material should consist of fine silk or nylon. A continuous running suture is made completely around the graft, the overlapping edges of the graft being sutured to the normal skin. This procedure is followed by the insertion of a sufficient number of sutures through the body of the graft to prevent slipping. Care should be taken in the central sutures to avoid the deep structures in the axilla, or the graft may be sutured around its edge with interrupted sutures, which are left long in order that they may be tied over the material used for compression. (Fig. 5.) Since the advent of sulfanilamide, sulfanilamide crystals are sprinkled over the graft. From 150 to 225 gr. (10 to 15 Gm.) is used, depending somewhat on the size of the grafted area. This is then covered with perforated gutta-percha or perforated foilloid and followed by the application of saline wet dressings. The graft should be kept moist for at least three to four days or until the first dressing, which should be done not later than the seventh postoperative day. The time to do the dressing depends on the postoperative course of the patient. To facilitate moistening of the dressings subsequent to operation several perforated Dakin's tubes are incorporated in the dressing.

The most important feature in skin grafting is the maintenance of a continuous even pressure dressing and this may be accomplished by employing sea sponges or sea foam rubber. (Fig. 6.) For immobilization an abduction humeral splint, any metal right-angled splint or such material as thick quilting may be used.

When the graft has taken which usually is noted from the sixth to the eighth postoperative day, the sutures are removed. If any blebs or areas of infection have formed beneath the graft, these should be opened and, if much infection is present, the sutures should be removed and the areas of infection painted with a 5 per cent aqueous solution of gentian violet or a 5 per cent solution of silver nitrate. It is also well to expose the infected areas to the air and give light treatments daily while continuing the wet dressings.

The postoperative care of the grafted area should consist of the wearing of an abduction splint for a period of from three to four weeks continuously and at night for a period of three to four months. This procedure lessens the risk of contractures. Scar contractures have not occurred to any appreciable extent in this series of cases but when evident or with the appearance of keloid formation, roentgen therapy may be employed beneficially. (Figs. 7*a* and *b*, 8*a* and *b* and 9.)

I should like to express my appreciation to Dr. J. R. McDonald for his courtesy in reviewing the microscopic sections.

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POSTOPERATIVE GASTRIC DRAINAGE*

QUANTITATIVE STUDY FOR AN INDICATION OF RE-ESTABLISHMENT OF GASTRO-INTESTINAL MOTILITY FOLLOWING GASTRIC OPERATIONS

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GASTRIC surgery, which until late in the nineteenth century was undertaken with certain misgivings, has increased in prevalence in recent years. This has been due not only to refinements in surgical technic but also to the improved methods in postoperative care that have led to a more favorable outcome. Continuous or intermittent suction applied to a tube passed through the nose or mouth into the stomach is an integral part of such care.

Since the stomach tube was popularized over a hundred years ago, there have been introduced a large and varied assortment of tubes for emptying the stomach. The Levine tube has perhaps met with the greatest favor. Likewise, numerous methods of applying suction to such a tube have been suggested. Of these the principle advanced by Wangensteen is as simple and effectual as any.

Postoperative intubation is advisable, following gastric operations, to protect suture lines against stress, to permit the patient to take water and other fluids after recovery from anesthesia, to prevent overdistention of the stomach with liquid and gas, and to rest the stomach until local edema and irritation have subsided. Regardless of the general condition of the patient, secondary edema will appear at the site of the operation and may delay gastric emptying for several days. Edema occasionally develops as a result of disordered body metabolism.

The overdistention that is observed may be due to any factor retarding gastric emptying time. It may arise from edema at the pylorus or around a newly formed stoma, or from diminished gastric activity due to reflex or other origin. The function of gastric emptying is taken over by an ectopic center if the pylorus is sectioned or if a gastroenterostomy or Billroth I type of operation is performed. After edema has subsided, any restraining influence on gastric motility, if such can be demonstrated, must be brought about by contraction of the intestine below the site of operation.

In the immediate postoperative period, patients who have been subject to gastric surgery must be carried along on parenteral fluids. The amount administered should be dependent upon the demands of the patient from the standpoint of fluid balance. The administration of parenteral saline increases gastric secretion as well as duodenal and biliary secretion, but to a lesser degree than does the lavage action of large amounts of fluid taken by mouth and sucked back by a tube draining the stomach.

Thus in patients who have had a gastric operation and are being maintained on parenteral fluids as well as on fluids by mouth, the amount of fluid that is removed from the stomach will be dependent upon several factors. The chief factor, of course, is the amount of fluid that is taken by mouth. Of less significance is the amount of parenteral fluid (saline or other solutions) that is being administered. Other factors are: obstruction that develops at a newly formed stoma due to operative or other edema, obstruction at the pylorus due to similar edema or pylorospasm, obstruction due to gastric or intestinal atony, and

* From the Abington (Pa.) Memorial Hospital, Surgical Service of Dr. Damon B. Pfeiffer.

obstruction due to intestinal contraction beyond the operative site. If gastric distention is to be avoided, tube-drainage of the stomach must be continued until such time as gastrointestinal motility is re-established.

The patient, suffering discomfort from the tube, and the surgeon, confronted not only with possible alterations in chemical balance from chloride loss through the tube but also with the problem of fluid-balance maintenance, are both interested in as early removal of the tube as is feasible. Various criteria for the re-establishment of motility which have been presented in the past are based chiefly on retention tests and have their disadvantages. They are usually "trial and error" procedures and entail the risks attendant on gastric distention in the early postoperative period. A simple method of determining such re-establishment, at which time the tube may be removed safely, is afforded if an accurate fluid-balance record is kept.

Such has been the plan of procedure since early in 1938 at the Abington (Pa.) Memorial Hospital. In addition, a Levine tube is passed, preferably preoperatively, through the nose into the stomach of every patient undergoing gastric surgery. Suction by the Wangensteen principle is applied to the tube postoperatively. On the fluid-balance record kept for such patients there is recorded item by item the amount, nature, time and route of all fluid intake and output. The amounts are summarized every twelve hours, thus giving a day and a night figure. Twenty-four-hour totals are likewise indicated. Parenteral and oral fluid intake are among the items noted as well as fluids lost by kidney and bowel. The degree of sweating is indicated. Thus at the end of each twelve or twenty-four hour period it is a simple matter to determine from such a record the changes in fluid balance for the body as a whole as well as the gain or loss as far as oral fluids are concerned.

When intake by mouth exceeds output by mouth (vomitus plus suction drainage) gastrointestinal motility is assumed to be re-established. For not only is the excess of intake over output being assimilated, but also an amount representative of gastric secretions. At such time the tube may be clamped off for increasing periods of time, and if there is no indication for further gastric drainage the tube may be removed. In the following series, after re-establishment of motility the tube was left in place for a period averaging about twenty-four hours.

The records of patients undergoing gastric surgery at the Abington (Pa.) Memorial Hospital during a five-year period (1934 to 1939) were analyzed to determine whether the re-establishment of gastrointestinal motility subsequent to gastric operations followed any definite time pattern. For the purposes of this study the exact time of removal of the tube had to be known. This was found in fifty-eight of the cases. The described fluid balance records were kept for the last twenty-one of the above fifty-eight cases. It is to the fifty-eight cases that attention is directed and to the twenty-one cases particularly.

If, for the sake of explanation, a curve is plotted for intake by mouth and a second curve is plotted for output by mouth as determined from the records, the discrepancy between the two represents the net differential which may also be plotted. When this latter curve falls below the zero line, motility is established. (Figure 1 gives the curves for a typical case.)

Table 1 includes all cases in which the duration of intubation was indicated. This is given for each type of operation encountered. Table II includes those cases in the first table which presented data not only on the duration of intubation but also on itemized fluid balance.

In Figure 2 are plotted net differential curves based on the twenty-four hour totals of fluid intake and output by mouth. These curves are averages for: (1) each operation of which there were four or more instances, (2) the remainder of the various operations and (3) the group as a whole. The similarity of the curves is noteworthy.

With the exception of those patients in which gastroenterostomy was the operation performed, the maximum degree of obstruction or the minimum degree of motility was reached on the day after operation. On the second day after operation the degree of obstruction, either mechanical or functional, remained elevated as indicated by the excess of output over intake by the oral route. In the case of gastroenterostomies, obstruction was observed to be at a maximum on the second

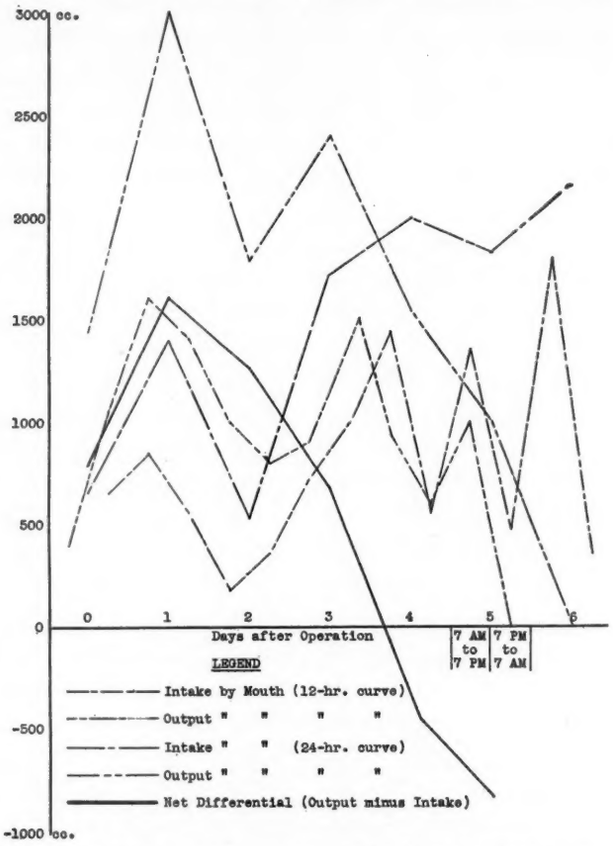

Fig. 1. N. H., Chart No. 38-4344. Bleeding duodenal ulcer; Finney pyloroplasty and suture of ulcer.

TABLE I

Number of Cases	Operation	Duration of Intubation (Days)	Average
1	Gastro- and cholecystojejunostomy	8	8
7	Polya gastric resection	11, 6, 6, 6, 5, 5, 4	6
1	Gastrectomy and esophagojejunostomy	6	6
2	Cholecystogastrostomy	7, 5	6
1	Excision of gastric myosarcoma	6	6
2	Closure of gastrojejunocolic fistula	6, 4	5
28	Gastroenterostomy	11, 8, 7, 7, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3	5
10	Finney pyloroplasty	7, 7, 6, 5, 5, 4, 4, 4, 4, 3	5
4	Closure of perforated ulcer	5, 5, 4, 4	4½
1	Gastrotomy and suture of ulcer	4	4
1	Heinicke-Mikulicz pyloroplasty	3	3
58		General average	5.2 days

day. The significance of the lag is not apparent. On the third day there is a subsidence of obstruction and on the fourth day after operation the average net differential, not only for each of the various groups but also for the entire series, has crossed the zero line. This would indicate that by the fourth day, and let it be stressed that this is in the average case, motility becomes re-established. It is during the first day after operation that there is the greatest increase in obstruction. This

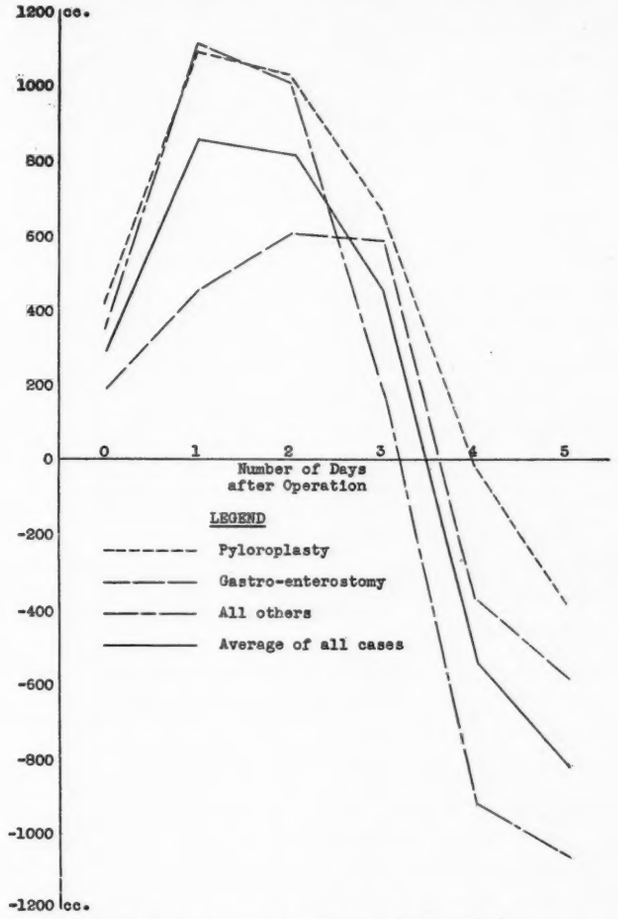

Fig. 2. Composites of net differentials.

TABLE II

Number of Cases	Operation	Duration of Intubation (Days)	Time for Differential to Reach Zero (Days)
1	Gastro- and cholecystojejunostomy	8	8
2	Polya gastric resection	11, 6	11, 4
1	Excision of gastric myosarcoma	6	5
2	Closure of perforated ulcer	5, 4	5, 4
4	Finney pyloroplasty	7, 5, 4, 4	5, 5, 4, 4
1	Closure of gastrojejunocolic fistula	4	4
8	Gastroenterostomy	7, 6, 5, 4, 7, 5, 3, 5	6, 5, 4, 4, 3, 3, 3, 2
2	Cholecystogastrostomy	7, 5	3, 1
21		Average....5.6 days	4.4 days

is quite natural as irritation is at a maximum. The cumulative action of those factors hindering motility subsides to the greatest degree during the fourth postoperative day. Then, as motility is reestablished, the curves of the net differentials level off and, after clamping or removing the tube, represent the oral fluid intake expressed as a minus value.

SUMMARY AND CONCLUSIONS

The prevalence and success of gastric surgery have increased in the last half century. Much of the gain may be attributed to improved postoperative care in which drainage of the stomach through one of the various tubes that have been presented plays an important rôle. Such drainage is adequately accomplished with the Levine tube to which suction is applied by the method of wangensteen. Drainage is indicated until gastrointestinal motility, interrupted by operation, is re-established. As a precautionary measure, the tube which otherwise might be safely clamped on the fourth day in the average case, should be allowed to remain in place for an additional twenty-four hours in those instances in which there is a question as to the permanent continuance of motility. The time of re-establishment of motility may be determined by analyzing a patient's record of fluid intake and output by mouth, when such a record is kept in detail following gastric surgery.

In a series of patients who were thus investigated, the time element with regard to motility after operation was established. Regardless of the type of operation on the stomach, motility in the average case was found to be at a minimum on the day after operation. By the fourth postoperative day, motility was found to be adequately re-established and subsequently continuous without remission.

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THE PREVENTION OF POSTOPERATIVE MENINGITIS BY INTRACRANIAL IMPLANTATION OF POWDERED SULFANILAMIDE*

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THE treatment of certain infectious diseases by the systemic administration of sulfanilamide has established itself as a notable achievment. This form of therapy has enjoyed no more spectacular success than in the treatment of meningitis, especially of streptococcic and meningococcic origin. Yet meningitis remains a dread complication of neurosurgical procedure, and methods useful in the reduction of the risk of meningeal infection may be fruitfully explored.

Bucy[1] has reported the value of sulfanilamide administered orally and parenterally in the prevention of probable meningitis, resulting from accidental contamination of the surface of the cerebellum during the drainage of a brain abscess. It was our purpose to test experimentally the efficacy of sulfanilamide in the prevention of meningitis, not by parenteral or oral administration, but by intracranial implantation of the powdered drug at the site of invasion of the organisms. That this form of administration might well be of value, was apparent from the work of Jensen, Johnrud, and Nelson[2] who demonstrated the prophylactic effectiveness of local implantation of sulfanilamide in the treatment of compound fractures. More recently, Rosenburg and Wall[3] found the intraperitoneal introduction of sulfanilamide powder of great value in the prevention as well as the treatment of peritonitis. Since this form of administration of the drug was found effective in the prevention of infection in a membrane as delicate as the peritoneum, its analogous use in the meninges was considered feasible.

The purpose of this work was to test the efficacy of sulfanilamide, locally applied, in the prevention of experimental postoperative infection of the meninges. A case report is presented to illustrate the use of this method in the prevention of meningitis following surgery for compound, depressed fracture of the skull.

EXPERIMENTAL PROCEDURE

A preliminary series of experiments with rats indicated that powdered sulfanilamide applied to the surface of the brain was neither toxic nor irritant. In the small group of rats studied, those in which the sulfanilamide had been implanted, survived; while the controls, not protected from the innoculation of a virulent culture, succumbed. The cultures used were predominantly Streptococcus hemolyticus. However, the operative procedure was so traumatizing in such a small animal, that extraneous factors rendered interpretation difficult. Cats proved pre-eminently desirable for this work, for in these animals, no mortalities occurred attributable to the operation alone.

Twelve cats, studied in six pairs, were used; one of each pair constituted the control animal. The infecting agent was obtained several days before each experiment from fresh pus obtained from patients with otitis media. The cultures were predominantly of streptococcic, containing occasional pneumococci and staphylococci.

* From the Neurosurgical Service and the Department of Pathology of the Montefiore Hospital, Pittsburgh. This work was made possible through the aid of a grant from the Isaac Kaufmann Foundation.

To insure infection of the leptomeninges, the virulence of the cultures was strengthened according to the method described by Groff.[4] This entailed subculturing in blood agar at 37°c. for twenty-four hours with re-introduction of part of the melted agar into broth. Thus a virulent culture was obtained, which produced a fulminating infection without fail in each control animal. This is all the more striking since, when a discrepancy existed, the larger or better nourished animal of each pair was used as the control.

The animals were etherized, and a burr opening about the size of a dime was made in the temperoparietal area. The dura was carefully opened stellate fashion, and the cortex gently scarified to insure contamination of the leptomeninges. After hemostasis was complete, 1 cc. of the virulent culture was injected subdurally, the culture flowing somewhat beyond the limits of exposed cortex. The technic was identical in every animal, except that in one of each pair, the introduction of the organisms was followed by the subdural implantation of approximately ½ Gm. of powdered sulfanilamide. The powder thus applied covered the leptomeninges and cortex as well as dura. By delicate probing, the drug was brought just beyond the outer limits of the exposed brain to reach as much of the infecting

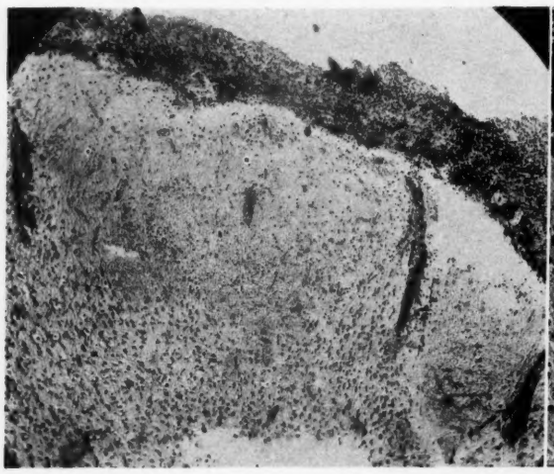

Fig. 1. A microphotograph demonstrating diffuse meningitis and inflammatory cortical change in a control animal. × 75.

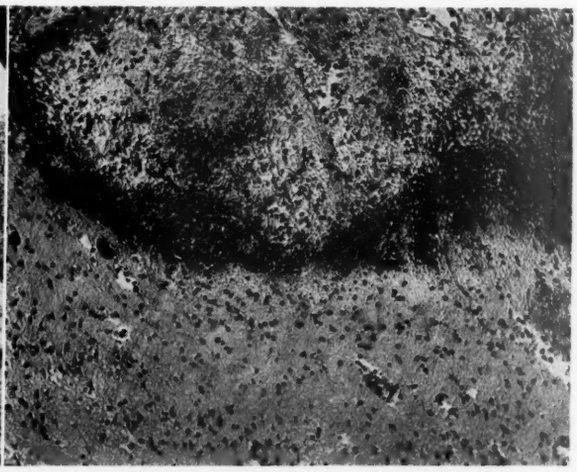

Fig. 2. A microphotograph demonstrating early subcortical abscess formation in a control animal. × 125.

TABLE I

RAT PROTOCOL

Animal	Date	Culture	Sulfanilamide	Course	Results
1.	12/20/40	0.25 cc. Hem. Strep.	None	Sick on 3rd day. Progressively worse; refused to eat	Died on 7th day, 12/27/40. Path. report: meningitis
2.	12/20/40	0.25 cc. Hem. Strep.	75 mg.	Well throughout	Living and well
3.	12/26/40	0.25 cc. Hem. Strep.	None	Very sick in 24 hours; refused to eat	Died 2nd day, 12/28/40. Path. report: meningitis
4.	12/26/40	0.25 cc. Hem. Strep.	75 mg.	Well throughout	Living and well
5.	1/2/41	0.25 cc. Hem. Strep.	None	Very sick in 12 hours	Died in 18 hours. Path. report: early diffuse meningitis
6.	1/2/41	0.25 cc. Hem. Strep.	75 mg.	Well throughout	Living and well

fluid as possible. Closure was made of temporal muscle and skin with continuous catgut sutures. The animals were kept in warm cages, and received routine postoperative care. Table I and II illustrate the protocols and results in the rat and cat experiments, respectively.

EXPERIMENTAL RESULTS

The results summarized in the cat protocols (Table II) exhibit a striking uniformity. All of the animals treated with sulfanilamide at the time of the operation and only at that time, survived for longer periods than the controls. Only one of the sulfanilamide-treated animals (No. 12) died, and this occurred eight days after the control animal had succumbed in twenty-four hours. At death, this treated animal was markedly distended and died apparently as a result of a fulminating toxemia due to secondary anaerobic invasion. There was no evidence of meningitis or cortical abscess. The brain appeared necrotic.

All of the control animals died with clinical and pathological evidence of meningitis. These animals demonstrated varieties of clinical and pathological pictures, ranging from death within twenty-four hours, from a fulminating invasion, to a maximum survival of seven days. Figure 1 is a microphotograph illustrating the suppurative meningitis obtained in cat No. 3. The sections show areas of polymorphonuclear infiltration, suppuration and necrosis, as well as new capillary formation and fibroblastic reaction. There is marked distortion of ganglion cells, edema and perivascular infiltration. Figure 2 illustrates a subcortical abscess seen in four of the six control animals. Most of the sections revealed dilated thrombosed vessels with perivascular polymorphonuclear leukocytic infiltration, focal necrosis and hemorrhage. Figure 3 is a microphotograph of the brain of one of the treated animals sacrificed for pathological study. Grossly the brain revealed no evidence of suppuration. On microscopic study, the meningeal vessels appeared somewhat engorged, and there was slight round cell infiltration, possibly the result of scarification and slight irritation. There was no evidence of infection or

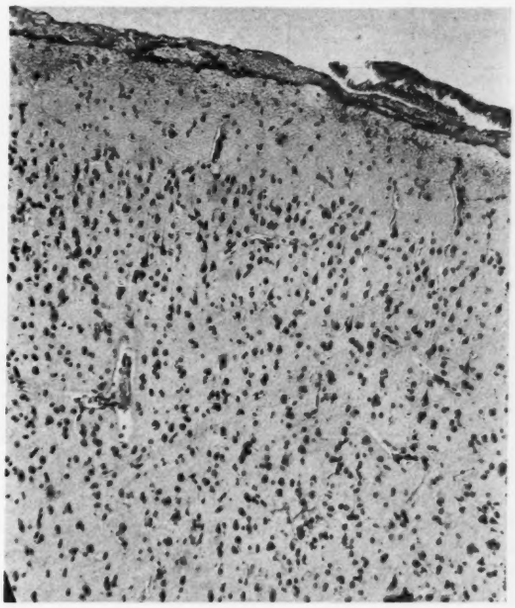

Fig. 3. A microphotograph demonstrating essentially normal dura and cortex in a sulfanilamide treated animal subsequent to scarification and injection with a virulent culture. × 100.

significant foreign body reaction. The contex appeared well preserved.

CASE HISTORY

The patient, a boy of eleven, was admitted to the Montefiore Hospital in stupor two hours after he had sustained a head injury in a fall from a tree. On admission, his condition was poor. The head revealed a small scalp laceration in the right parietal region, through which cortical tissue oozed. Pupils were sluggish and reacted poorly to light. There was no gross paresis. The patient was given 100 cc. of hypertonic glucose intravenously, and a spinal tap was performed to relieve the stupor and extreme restlessness. Because of the possibility of incipient shock, operation was postponed until ten hours after admission. Tetanus antitoxin was given, and an .8 per cent sulfanilamide clysis instituted.

At operation, an extensive compound depressed fracture of the right perietofrontal region was disclosed. A radical débridement of the skull and cortex was carried out in accordance with the technic outlined by Munro. Because the fracture extended beyond the limits of possible exposure, the débridement

TABLE II

CAT PROTOCOL

Animal	Date	Culture	Sulfanilamide	Course	Results
1.	1/20/41	0.5 cc. Hem. Strep.	None	Lethargic in 24 hours, with swelling over operative site, on 4th day very sick, large abscess present; cat in extremis 6th day; sacrificed	Path. diagnosis: suppurative meningitis; cortical abscess
2.	1/20/41	0.5 cc. Hem. Strep.	0.5 Gm.	Slightly ill 1st day, then well throughout; sacrificed in 12 days to examine brain	Path. diagnosis: slight injection of meningeal vessels
3.	1/31/41	1 cc. Hem. Strep.	None	Lethargic in 24 hours; swelling over operative site; eyes swollen, quite sick, does not eat; progressive signs of meningitis; died on 7th day	Path. diagnosis: suppurative meningitis; cortical abscess
4.	1/31/41	1 cc. Hem. Strep.	0.5 Gm.	Condition good next day; well throughout, sacrificed on 14th day for pathological study	Path. diagnosis: no evidence of suppurative meningitis or foreign body reaction; brain and meninges essentially normal
5.	2/4/41	1 cc. Hem. Strep.	None	Lethargic in 24 hours; swelling over operative site; eyes glassy; progressively worse; classical signs of extensive meningitis; died 6th day	Path. diagnosis: diffuse suppurative meningitis; cortical abscess
6.	2/4/41	1 cc. Hem. Strep.	0.5 Gm.	Condition good next day; well throughout	Still living; excellent condition
7.	2/11/41	1 cc. Hem. Strep.	None	Lethargic in 24 hours; on 2nd day, shallow respirations, paralytic rigidity hind legs; died on 3rd day in extreme rigidity	Path. diagnosis: suppurative meningitis; cortical abscess
8.	2/11/41	1 cc. Hem. Strep.	0.5 Gm.	Slightly ill 1st day; 2nd day much better, then well throughout	Still living; excellent condition
9.	2/14/41	1 cc. Hem. Strep.	None	Extremely ill, slight swelling over operative area. Died within 24 hours	Path. diagnosis: diffuse meningitis
10.	2/14/41	1 cc. Hem. Strep.	0.5 Gm.	Rather ill 1st and 2nd days, walks around, eats very little; condition improved 3rd day, then well throughout	Still living; excellent condition
11.	3/4/41	1 cc. Hem. Strep.	None	Dead in 24 hours	Path. diagnosis; diffuse meningitis
12.	3/4/41	1 cc. Hem. Strep.	0.5 Gm.	Ill 1st and 2nd days; on 3rd day cat eating a little and looks better; 7th day suddenly became worse, and entire body swelled rapidly before death on the 8th day postoperatively	Died 8 days postoperatively; no evidence of suppurative meningitis; brain appeared necrotic

could not be complete. Therefore, 4 Gm. of sulfanilamide powder were dusted into the wound. The powder was in intimate contact with the traumatized brain as well as the skull margins. Closure of the galea and skin was made with interrupted silk sutures without drainage. During the operation, the patient's circulation had been sustained with a transfusion of 500 cc. of blood, and his immediate postoperative condition was good. On returning to his room, the .8 per cent drip was re-instituted.

The patient's course in the hospital was quite satisfactory. A temperature of 103° (per rectum), noted forty-eight hours after operation, was the peak of the curve. At no time was there evidence clinically or on spinal fluid examination of meningitis; nor was there any evidence of a toxic reaction to sulfanilamide. The patient has been well since discharge from the hospital more than six months ago.

DISCUSSION

The clear experimental results demonstrate the efficacy of powdered sulfanilamide implanted intracranially in the prevention of meningitis. While the organisms were predominantly streptococci, pneumococci and some staphylococci were also present. Lockwood[5] stresses the importance of high concentrations of the drug at the site of contamination if the most beneficial results are to be obtained. He emphasizes the view that the future progress of chemotherapy rests on the ability of obtaining high concentrations at the desired site rather than increased drug specificity.

It appears that sulfanilamide is without harmful effect when locally applied in powdered form to the leptomeninges and cortex of cats. Russell and Falconer[6] proved that no appreciable damage was sustained by the local application of sulfanilamide powder to the rabbit's brain. They warn that excess of the powder will excite a foreign body reaction. In our experiments, estimation of foreign body reaction was difficult because of the cortical scarification and subsequent innoculation. We could, however, see no significant evidence of a process of this kind. Furthermore, clinically, this form of administration of the drug finds its most suitable application in the treatment of potentially infective cranial and intracranial injuries. In these conditions, the reparative changes are usually far more extensive than any demonstrable foreign body reaction to this chemical. Therefore, the foreign body reaction is a relatively unimportant consideration, especially when the possibility of severe infection exists.

In our patient, there was no clinical evidence of any toxic effect from the local application of 4 gm. of sulfanilamide to the brain surface, traumatized though it was. While our clinical case does not determine whether or not the intracranial use of sulfanilamide prevented meningitis, because of the surgery and parenteral administration of the drug, it does demonstrate that in this instance, it produced no untoward effects. It must be emphasized that the use of powdered sulfanilamide in potentially infected areas does not eliminate the necessity for a sound surgical prodecure, such as débridement of a compound fracture of the skull. However, when the débridement as in our case, is necessarily incomplete, local implantation of sulfanilamide may prevent a suppurative meningitis. Its use may well diminish the number of cases in which disfiguring surgery is deemed necessary in order to complete an extensive débridement of the skull. During war, this method may achieve its widest application in preventing the disfigurement of excessively radical surgery, or death from meningitis.

SUMMARY AND CONCLUSIONS

1. The intracranial implantation of powdered sulfanilamide is an effective and efficient method of preventing meningitis experimentally produced in cats by the subdural injection of a culture, predominantly streptococci. Thus, effective high concentrations of the drug, applied locally and prophylactically, when infection seems likely, may often spare healthy organs from intensive chemotherapy.

2. A case is presented illustrating the clinical application of this method, and demonstrating the apparent harmlessness of sulfanilamide dusted on traumatized cortex.

3. The value of this method in the prevention of infection of the meninges, especially in traumatic neurosurgery, is discussed.

We wish to express our sincere thanks to Dr. K. Y. Yardumian, Chief of the Laboratory, for his valuable advice during this investigation, to Mr. A. Levin for the microphotographic studies and to Miss Rhea Klein for her help with the bacteriological work.

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The only true hyperplasia of the connective tissue in the thyroid gland is found as the end result of a defensive reaction; that is, thyroiditis.

BIOCHEMICAL ASPECTS OF PREOPERATIVE AND POSTOPERATIVE TREATMENT*

ITS PRACTICAL APPLICATION

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ADVANCES in surgical technic were followed by an increasing recognition of the importance of improved preoperative and postoperative treatment. Increased knowledge in anesthesia, a better understanding of peripheral circulatory failure and shock, the prevention of pulmonary complications, thrombosis and embolism, and intestinal distention, were emphasized, and in the past decade have assumed their rightful place in the care of surgical patients. In the past few years, however, clinical and experimental research have also emphasized the significance and importance of a biochemical evaluation of the surgical patient, and it is this aspect with which this communication is concerned.

The categories to be discussed concern themselves with: (1) Fluid and electrolyte balance, (2) hypoproteinemia and its relationship to edema, its effect on gastrointestinal motility, and its relationship to wound healing and wound disruption, (3) nitrogen balance, and (4) vitamin C and its importance in wound healing and wound disruption. A prime purpose of this presentation is to show that the determination of all the above is a practical procedure to be carried out in the great majority of patients, and is not merely a theoretical consideration and one which requires highly organized laboratory and research facilities.

FLUID AND ELECTROLYTE BALANCE

Physiologic Consideration. There are numerous conditions which predispose to dehydration. Among the more common are prolonged diarrhea, vomiting incident to obstructive lesions, inanition secondary to ulcer or carcinoma, traumatic shock, etcetera.[13] We are, however, concerned here chiefly with surgical considerations. Electrolyte loss occurs chiefly through vomiting resulting from obstructing lesions of the gastrointestinal tract. The chloride ion is the principal electrolyte lost with gastric juice. If the loss of the chloride ion is sufficient, hypochloremia and alkalosis ensues. Similarly, the sodium ion is the principal electrolyte lost with pancreatic juice and bile, and if this loss is sufficient, acidosis ensues. Sufficient bile may also be lost via biliary fistulae to produce this picture. If the loss is from the lower reaches of the gastrointestinal tract, as from jejunostomy or ileostomy, there is a loss of unabsorbed electrolytes. In prolonged diarrhea, similar changes follow.

In the consideration of the physiologic aspects of patients in whom there is a disturbance of water and electrolyte balance, the *degree of hydration*, the *electrolyte balance*, and the *nutritional state* must be considered.

The water of the body is divided into three components: the intracellular and the extracellular, the latter composed of *interstitial* and *intravascular* portions. The interstitial portion is about three times as large as the intravascular portion, and its volume varies considerably in varying degrees of hydration, while the intravascular portion, or plasma volume is maintained at fairly constant levels. The important problem in the analysis of the extent of hydration is the determination of the volume of interstitial fluid and the extracellular volume. It is difficult to determine directly

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the extracellular water, but it can be arrived at indirectly by the determination of the plasma. It has been shown[12] that the plasma volume up to a certain point, is maintained at the expense of the interstitial water during extracellular water loss, but beyond this the plasma volume diminishes with consequent hemoconcentration. Thus hemoconcentration and reduced plasma volume indicates a serious reduction of extracellular fluid. A change in plasma protein concentration, if protein has not been added or lost, may presume changes in plasma volume. Obviously then, determinations of these are important in determining the severe degrees of dehydration.

In the considerations of proper therapy, it will be apparent that the electrolytes replaced will obviously depend upon the electrolytes lost. With loss of chlorides, only moderate amounts of solutions are given, as here both water and electrolyte retention are greater. With sodium loss on the other hand, larger amounts may be given, as neither electrolytes nor water will be retained, obviating the danger of retention edema.[15] In the acutely ill and dehydrated patient it is sometimes insufficient to give sodium chloride alone, for at times the blood is found more concentrated after its administration, and here the use of adrenal cortical extract will help fix the sodium.[14] It will be shown that in hypoproteinemia, when there is already a fixation of the sodium chloride and water in the tissues, the use of adrenal cortical extract is obviously contraindicated.

It can thus be seen that the indiscriminate administration of fluids, either salt solution or even glucose, is not without hazard, and it is also reasonable to assume that the quality and quantity of fluid given must vary with each patient and with different states of fluid balance. For example, the renal function is impaired in marked dehydration, and the administration of large amounts of salt solution is often associated with edema. Thus for the correction of the former, glucose solution rather than salt solution is indicated, and its administration results in an increase of renal blood flow, an increase of plasma volume, and does not usually predispose to edema. Thus is demonstrated the fallacy of the administration of salt solution under improper conditions. In dehydration, hypertonic fluids will be deleterious, for it is well known that hypertonic glucose solutions are effective in inducing dehydration. Also administration of excessive fluids even of *proper* concentration is to be avoided, for in patients with a reduced serum protein level, edema is likely to result.

Following these introductory remarks, it will be shown that the amount of fluid to be administered can be determined with a satisfactory degree of accuracy by one of several methods:

1. In the patient who is not vomiting, and can retain fluids by mouth, the problem is fairly simple. The usual fluid intake (including that in the diet) is approximately 3,000 cc. per day. If the urinary output is about 1,500 cc. daily, and the specific gravity 1.015, one may assume that the fluid intake and electrolyte balance is adequate.[1]

2. In the patient who cannot take fluids by mouth and must, therefore, receive parenteral fluids, several methods for determination of fluid requirements have been put forth: (*a*) *By calculation of total requirement for twenty-four hours.* The sum of the following represents the usual daily requirements: 1,500 cc. of water for urine, 2,000 cc. of water for vaporization, numerical replacement of fluid lost in vomitus, drainage from fistulae, hemorrhage, etc. If the patient is severely dehydrated, an additional 3,600 cc., or 6 per cent of the body weight may be given. (*b*) *By simultaneous determinations of chlorides* and *carbon-dioxide combining power.* These determinations indicate the total base, which according to Elkinton and associates[2] and Peters[21] is the important factor, as the total base determines the amount of water held in the tissues. However, the ratio of acid to base ions is important rather than just the total base concentration. In addi-

tion to dehydration there may be either acidosis or alkalosis. The determination of plasma carbon dioxide combining power and plasma chlorides, from which the total base may be calculated, as will be shown below, is important in following the electrolyte balance.

Methods of Determination of Chlorides and Carbon-Dioxide Combining Power. About 5 cc. of blood is drawn and placed directly into a Sanford-McGath hematocrit tube containing the proper amount of heparin. After centrifugation, the hematocrit is read. The protein can be determined from a few drops of plasma from its specific gravity by use of the Barbour and Hamilton's falling drop apparatus.[8] Residual plasma is used to determine the carbon dioxide combining power and chloride concentration. The mathematical calculations and interpolations necessary to obtain the appropriate figures for electrolyte determinations are beyond the scope of this presentation, and for the formulae, one is referred to other articles.[2]

Administration of Fluids. A simple method of giving parenteral fluids is the administration of physiologic saline in 5 per cent glucose in amounts equal to the gastric, biliary, intestinal, etcetera, loss, plus 5 Gm. of sodium chloride for urinary excretion, and 1,000 to 2,000 cc. of a 5 per cent glucose solution to equalize the insensible loss.

Although base loss is important, acid ions must not be overlooked; replacement is in physiologic proportions. About three-fourths of the total base requirement is given as isotonic saline and one-fourth as sodium lactate or bicarbonate. If the carbon dioxide combining power or plasma chlorides are reduced, these must be restored by the administration of more sodium chloride, bicarbonate, or lactate as needed, and alkalosis or acidosis avoided. This method of attack aims at obtaining normal physiologic concentrations of base and acid ions, and water.

(*c*) *By determination of plasma chlorides.* Coller and associates[3] calculate the amount of physiologic saline needed by the so-called "clinical rule": for each 100 mg. that the plasma chloride level needs to be raised to reach the normal of 560 mg. per cent, the patient should be given 0.5 Gm. of sodium chloride per kilogram of body weight.

This method offers a simple and adequate technic for the determination of necessary *electrolyte.* According to Elkinton,[2] however, this method is not completely satisfactory as it ignores total base as such and hemoconcentration as an indicator of serious loss of extracellular water and electrolyte. The importance of the latter has been brought out in the preceding paragraph.

If no dehydration exists, but nothing is taken by mouth, and parenteral fluids are required, 500 cc. of physiologic saline solution or Ringer's solution, with 2,500 to 3,000 cc. of 5 per cent glucose in distilled water, will satisfy the patient's requirements.

It might also be stated that in diarrhea and ileostomy drainage, the base loss is greater than the chloride loss; here one finds a nearly normal plasma chloride, but a low carbon dioxide combining power. If there is vomiting, the chlorides are of course reduced. In cases with such base loss, Hartmann has presented a method for fluid and electrolyte correction.[4] According to this author, chemical examination of the blood will determine the loss of water, chlorides, bicarbonate, and total fixed base, but other substances as calcium and potassium are not so indicated because their concentration in the blood plasma remains fairly constant. He emphasizes that the calcium and potassium should, however, be considered, and to accomplish this, Ringer's solution should be given. The bicarbonate content of the blood and body fluids can be restored by *separate* injections of sodium bicarbonate and Ringer's solution. However, instead of separate injections, if sodium lactate is substituted for sodium bicarbonate, the sodium lactate can be combined with Ringer's solution, as these two are *compatible.*

Ringer's solution is indicated when chlorides, sodium, potassium, calcium and magnesium have been lost. It is thus applicable in all forms of dehydration, and as has been previously stated, when large amounts of gastrointestinal secretions have been lost as by vomiting, diarrhea, fistula, etc., Hartmann suggests the giving of 80 to 100 cc. per kilogram of body weight.

Sodium lactate solution is indicated in specific amounts in acidosis. As it is generally used when the carbon dioxide content is under 25 volumes per cent, a routine dose of 10 cc. of the molar solution per kilogram of body weight, diluted with 5 volumes of distilled water, will tend to raise the carbon dioxide content by 25 to 35 volumes per cent.

Lactate-Ringer's solution is indicated in all types of dehydration as this solution relieves acidosis or alkalosis and is especially useful when chemical blood determinations are not available. It may be administered by any parenteral route. When severe dehydration and loss of electrolytes exists, an initial dose of 80 to 100 cc. per kilogram of body weight may be indicated. However, it must be emphasized that after this initial dehydration and loss of electrolytes is corrected, the daily dose of Lactate-Ringer's solution must not be over 25 cc. per kilogram of body weight. The remainder of the fluid requirements are met with 5 per cent glucose.

(d) Determination of *hematocrit, specific gravity of whole blood and plasma, and computation of plasma protein.* It has been shown that these give valuable information regarding the state of hydration.[10]

Hematocrit. The determination of the hematocrit or cell volume is important, as there is characteristically an increase, no matter what the cause of the dehydration. The normal hematocrit for the male averages approximately 46 per cent and for the female the average is approximately 41 per cent. The hematocrit also gives important information about the plasma volume. If there is no change in erythrocytes, either by hemorrhage or transfusion, successive hematocrit determinations show changes in plasma volume.[20] The complete technic for these tests can be found elsewhere.[5]

Specific Gravity. That the specific gravity of whole blood and plasma varies with hemorrhage and edema, and with shock and dehydration, has been demonstrated.[11] Specific gravity determinations can be done by the simple method of Barbour and Hamilton.[7,8,9] According to this method, the normal average value of the specific gravity of whole blood is 1.0566 for males, and 1.0533 for females. The specific gravity of normal plasma is 1.0270, and this corresponds to a plasma protein of 6.83 Gm. per cent. The specific gravity is increased in shock and dehydration, and decreased in hemorrhage and edema.

Plasma Protein. It has been shown that there is a definite relationship between the the specific gravity of blood plasma and plasma protein content.[6] Knowing the specific gravity of blood plasma, the plasma protein content can then be determined by reference to appropriate tables. The further significance of this will be brought out more fully in the consideration of hypoproteinemia.

SUMMARY

Methods have been presented by which the state of hydration of patients can be determined with reasonable accuracy; and that when these determinations have been made, the administration of fluids, correct qualitatively and quantitatively, can be accomplished. The carbon-dioxide combining power, and chlorides, gives important, and probably the best data for accurate control, of course in conjunction with the clinical signs. That an understanding of these principles will aid substantially in restoration of fluid and electrolyte balance needs little additional comment.

HYPOPROTEINEMIA

Physiologic Consideration. An important function of plasma proteins is to maintain the colloid osmotic pressure of the

blood plasma. The osmotic pressure that the colloids exert against the capillary blood pressure prevents the fluid from leaving the capillaries into the surrounding tissues. A reduction of the colloid osmotic pressure causes a decrease in the ability of the plasma to retain water, and with this reduced plasma protein concentration, edema results. It has been shown that a depletion of plasma protein to the level of 4 to 4.5 Gm. per cent represents the critical level, and thus when the depletion is approximating this level, it can be reasonably predicted that edema will present itself. However, there are probably fluctuations in the figure.

Since in hypoproteinemia there is a lack of ability for plasma to retain water, injection of large amounts of various salt solutions obviously results in edema, whereas under other conditions, edema does not occur. This definitely illustrates that in hypoproteinemia there is a reduction in the ability to hold fluid in the blood, and a consequent escape and accumulation of abnormal amounts in the tissue spaces.[12] As the plasma proteins are diminished, there is a loss of fluid from the blood vessels, the edema at first being latent, and if continued, it becomes evident.[16] The mere replacement of fluid and electrolytes is insufficient without consideration at the same time of plasma proteins. In some instances a disturbed electrolyte balance takes place not because of a primary plasma protein deficiency, but because the capillaries have been so injured that plasma protein and crystalloids pass through the capillary walls into tissue spaces. Trauma and consequent oxygen lack frequently cause such increased capillary permeability. It has been shown that the fluid escaping at the site of burns closely corresponds in composition to that of serum,[18] and Beard and Blalock[19] found that the protein content of fluid lost as a result of burns, inflammatory processes, of distention of the intestine with interference of circulation, is similar to the protein content of plasma.

Although nutritional hypoproteinemia rarely leads to severe circulatory failure, its consideration and correction assumes definite surgical importance, for it will be shown that there exists a relationship between hypoproteinemia and certain postoperative complications.

With this as a brief basic explanation of the biochemical mechanics, those conditions which predispose to hypoproteinemia will be mentioned, and the resultant effects of hypoproteinemia of surgical significance discussed. Among the more common conditions leading to hypoproteinemia are deficient protein intake, deficient protein synthesis, hemorrhage, infection, extensive burns, loss by drainage, or in severe liver disease, in which the power to regenerate serum proteins is greatly diminished. In patients with ulcer or gastric cancer, because of restriction in diet for various reasons, there is undernourishment with protein starvation and ensuing hypoproteinemia.

A. Nutritional Edema. The capillary blood pressure tends to force fluids into the tissues while the colloidal osmotic pressure draws fluids from the interstitial spaces into the blood stream. In this reaction plasma protein is a dominating factor.[28] More detailed explanation of the mechanics can be found in other works.[29] Hence, because of the reduction of the osmotic pressure of the blood, there is a disturbance of water balance and a resultant peripheral, visceral and pulmonary edema, the latter often resulting in pneumonia.[17] Peripheral edema, manifested chiefly in the subcutaneous spaces is an early and frequent occurrence. Visceral edema will be discussed under gastrointestinal motility. Pulmonary edema can occur in a hypoproteinemic patient receiving small amounts of fluid, even though the patient is in negative water balance, emphasizing again the importance of hypoproteinemia.

B. Gastrointestinal Motility. As has been stated, when the plasma protein concentration falls below a certain level, the osmotic pressure which the plasma exerts is

reduced and fluid leaves the vessels, resulting in an increase in extravascular fluids, which if continued leads to edema.[22] In this process of edema the gastrointestinal tract is not excluded. It has likewise been shown that a reduction of the plasma protein of a dog will result in a marked increase in the gastric emptying time.[23] This in some instances becomes so prolonged that a technical defect in an anastomotic stoma is simulated. Persistent vomiting is often attributable to this cause. Disturbances in the motility of the gastrointestinal tract due to diminished plasma proteins are also emphasized by Barden and associates[25] and Mecray.[23] Restoration of serum proteins causes a prompt amelioration of these obstructive symptoms. It is well to remember also that hypoproteinemia can develop quickly following extensive operations upon patients who prior to operation appeared in good nutritional balance.[29]

C. Wound Healing and Wound Disruption. It has been shown that the healing of wounds follows a fairly exact mathematical formula.[26] In dogs rendered hypoproteinemic by diet or plasmapheresis, it was demonstrated that there was a delay in fibroblastic proliferation and consequently in wound healing. Contraiwise, in the absence of hypoproteinemia there was no delay in the healing of wounds.[27] More weight is lent to these conclusions when it is remembered that, as Ravdin[24] states "disruption is still encountered in wounds free from infection, in which hemostasis was excellent, in which trauma to tissues and tension was minimal, and unusual strain obviated," and this "strongly supports the concept that other factors of a general character play an important part in the failure of certain wounds to heal." The importance of serum protein in wound healing was forcibly demonstrated by Thompson,[30] who showed that even though there was still edema of the wound edges for some time after the serum proteins became normal, wound healing progressed.

Correction of Hypoproteinemia. All surgical patients should have their nutritional status determined, and if the serum proteins are found to be diminished, normal levels should be reached prior to operation, if possible. This restoration is at times difficult, especially when there is impairment of regeneration. In these cases proteins or amino acids cannot be utilized for synthesis of serum protein. However, in most patients such a factor does not pertain, and there is no defect in the regenerative factors of serum protein. The hypoproteinemia is merely nutritional in origin.

In cases with chronic loss of the protein fraction of the plasma, protein-containing fluids are to be administered. A variety of substances have been recommended, among them being lyophileplasma, amino acids, acacia solutions, ascitic fluid, serum and plasma, and whole blood. All but the latter two will receive but brief explanation here. The plasma offers the most rapid avenue of correcting nutritional hypoproteinemia. *Lyophilized plasma* has been suggested.[36] Details of the lyophile process for those interested are described by Mudd and associates.[37] *Amino acids* likewise have been used, and more detail will be given in the discussion of nitrogen balance. *Ascitic* fluid has been used,[38] and some interesting observations have recently been recorded by Maes and Davis.[39]

Whole blood or plasma are chiefly used. Whole blood is especially useful when the hypoproteinemia is associated with anemia. It is important to give multiple, large, and frequent transfusions if a definite rise in serum protein is to be reached and maintained.[29] If no anemia is present, plasma or serum is superior to whole blood, because it does not overload the system with unnecessary corpuscles. The relative ease of obtaining ready serum or plasma, and the absence of reactions, presents obvious advantages over whole blood. Here likewise large amounts must be given.

SUMMARY

It has been amply shown that protein deficiency and hence hypoproteinemia assumes great importance in the consideration of the surgical patient. Edema, interference with gastrointestinal motility

and the failure of normal function of anastomotic stomas, as well as major disturbances in wound healing, are sequelae following its failure of correction. The edema is the result of hypoproteinemia and is due to a disturbance in the mechanics by which there is a reduction in the colloid osmotic pressure with a consequent decrease in the ability of the plasma to retain water. In view of the latter, the danger of administering salt solutions in the presence of hypoproteinemia should be kept in mind, as edema might be precipitated because the sodium chloride and water becomes fixed in the tissues.

In those cases in which there is no intrinsic condition which results in impairment of regeneration, substitute therapy is of definite value. Perhaps the best means of increasing serum proteins is offered by plasma transfusions.

NITROGEN BALANCE

In addition to establishing fluid and electrolyte balance and correcting hypoproteinemia, the importance of maintaining the patient in nitrogen balance is receiving deserved increasing attention.

Physiologic Considerations. Body proteins are being constantly destroyed, and obviously must be adequately replaced. If this is not accomplished, the patient will of course not be in nitrogen balance, as the nitrogen loss will be greater than the available usable nitrogen. This problem arises in the patient who must be fed parenterally. This group is represented by patients with repeated vomiting as in intestinal obstruction or peritonitis; or in those in whom oral feedings are unsatisfactory, as in intestinal fistula or severe ulcerative colitis with diarrhea, by virtue of the fact that sufficient food cannot be tolerated, or perhaps is excreted before being sufficiently absorbed, and the tissues thus do not receive any adequate supply of amino acids. Under these circumstances enumerated above, it becomes apparent that amino acids, if possible, must be given parenterally. That such can be done has recently been demonstrated.[31]

Amino Acids for Intravenous Alimentation. It has been shown that amino acids in the form of an enzymatic casein hydrolysate is utilized for the nutritional needs by patients[31,32] and that it can be given safely has been repeatedly confirmed.[31,33] Altschuler and associates[33] have shown that casein hydrolysate to which has been added 1.8 per cent tryptophane and 1.5 per cent cystine can be administered intravenously to postoperative patients without deleterious reactions, and the patient can be maintained in nitrogen balance when this amino acid mixture is substituted for protein in the diet. Also, amino acids were completely utilized and nitrogen balance maintained. Marked improvement was also noted in patients with nutritional edema.

Plasma for Alimentation. Plasma also can maintain the patient in nitrogen balance,[34] but has some important shortcomings as a means of *nitrogenous nourishment.* It would require 1,000 cc. of blood to represent the equivalent of 35 Gm. of serum protein, the latter being the minimum for a 70 kilogram adult.[31] The impracticability of this is evident. Furthermore, plasma supplies the protein for serum protein only, but it is likewise necessary for other tissues to be supplied, and this is accomplished only by amino acids, as the latter represents the form in which protein enters the blood stream. The protein must physiologically first be hydrolyzed to amino acids.

Method. For the amount of amino acid to be administered intravenously, Elman and Weiner state "with regard to the quantity of dextrose and amino acids needed for intravenous alimentation, a rough estimate should be made. For a 70 Kg. adult certainly 1600 calories should be given, and more if fever is present. Thus at least 400 grams of dextrose and amino acids should be injected. Of the latter, sufficient should be given to keep the patient in positive nitrogen balance. From the various statements in the literature, at least 0.5 *Gm. per kilogram* should be adequate. In the adult patients observed in which the excretion of nitrogen was

studied for a long period, 5 Gm. a day was the usual maximum output. This corresponds to an amino acid intake of over 30 Gm. In other patients the nitrogen needs are probably much greater."

Reactions from administration of amino acids have been minimal. It might be added that amino acids in solution have been prepared commercially.

SUMMARY

The importance of maintainance of nitrogen equilibrium has been brought out. A mixture of amino acids containing essential constituents is available and can be administered parenterally without untoward reactions.

VITAMIN C

The importance of protein as a factor in wound disruption and would healing has been emphasized. Protein deficiency, however, is not the only factor to be considered. It has been established that vitamin c deficiency is a contributing factor to this complication. It has been shown experimentally that this deficiency has led to poor healing of surgical incisions.

The basis for the relationship of vitamin c to wound healing is perhaps best briefly explained by Hartzell et al.[44] who quote Wolbach and state that "deficiencies of Vitamin C result in abnormalities of all intracellular substances having collagen as their basis, and that its absence prevents the formation of the matrices of white fibrous tissue, bone, cartilage, and dentin." Also, "in Vitamin c deficiency the pathologic picture is produced by resorption of intracellular materials in both growth and reparative reactions."

The fact is not lost sight of, however, of the part in poor wound healing and disruption played by faulty technic, unnecessary trauma, poor hemostasis and infection.

Patients with gastric and duodenal ulcer have been shown to have low vitamin c levels in blood plasma,[41] as well as patients with gastric carcinoma, biliary tract disease, severe diarrheas or with chronic sepsis. Significant also is the fact that the vitamin c plasma level drops considerably after operations *without* clinical signs of scurvy, even if the plasma level reaches zero. This obviously should impress one with the importance of keeping the vitamin c nutrition in mind but perhaps suggests the importance of prophylactic administration. It is also well known that a vitamin deficiency is rarely singular, and according to Lund and Crandon,[48] when large doses of vitamin c are given, thiamin hydrochloride, and nicotinic acid are also important. They give 1 Gm. of ascorbic acid, 30 mg. of thiamin hydrochloride, and 100 mg. of nicotinic acid daily for four days before operation. Vitamin therapy is carried out also postoperatively.

GENERAL SUMMARY

An attempt has been made to present some fundamental principles of therapy from a biochemical point of view. For those patients who cannot take fluid or food by mouth, parenteral therapy becomes necessary; and if the fundamentals presented are kept in mind, the water and electrolyte balance can be restored in each individual patient with considerable mathematical accuracy. The effect of protein deficiency has also been amply demonstrated. A reduction in the concentration of plasma proteins results in peripheral and visceral edema, and often explains the apparent failure of anastomotic stomas to function normally. Its relationship to wound healing is discussed. The importance of maintaining the patient in nitrogen balance is dealt with, and the exhibition of amino acids in patients not in nitrogen equilibrium, although not satisfactorily solved, is making headway. Experimental and clinical evidence is accumulating to demonstrate the importance of vitamin c in wound healing.

I wish to thank Dr. Warren H. Cole for many helpful suggestions.

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PERITONEOSCOPY*

WITH SPECIAL REFERENCE TO WIDENING ITS APPLICATIONS

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PERITONEOSCOPY no longer requires introduction or apology. Its safety, simplicity and accuracy in abdominal diagnosis have been ably demonstrated by Ruddock,[1,2] Benedict,[3] Thieme,[4] Olim,[5] and others. There are now, in fact, over 300 peritoneoscopes in use throughout this country, the Ruddock peritoneoscope being the most widely accepted. I propose in this paper first to summarize briefly my experience with the peritoneoscope and then to describe some new or only slightly exploited applications.

PERITONEOSCOPY IN GENERAL

The reader is referred to the authors just mentioned for details of technic which consist, briefly, in four steps: local anesthesia, abdominal air inflation, insertion of the instrument through a small stab wound, observation and, when indicated, biopsy.

Two points deserve emphasis: the relative painlessness of the procedure and its safety. Although Priestly[6] recommends intravenous evipal, we have found local anesthesia quite satisfactory. Special note was made of the amount of pain during our last fifty-three peritoneoscopies: thirty-nine patients either had negligible pain or none at all, nine made moderate complaint and only five complained bitterly. Supplimental anesthesia was necessary just once. Four well sedated patients fell asleep during the procedure. The day following peritoneoscopy the patient is allowed up and around.

The safety of the procedure is well illustrated by Ruddock's[2] 900 observations with but a single mortality. There have been no known cases of peritoneal infection in the present series and I have encountered none in the literature. In one of our patients with terminal though atypical tuberculous peritonitis, a loop of ileum was punctured and the resulting fecal fistula doubtless hastened somewhat the inevitable fatal conclusion. Another patient in the last stages of syphilitic cirrhosis of the liver, lung abscess and cardiac decompensation expired two hours after peritoneoscopy. Although autopsy revealed no evidence of injury, the procedure undoubtedly gave the final tip to the balance between life and death. Since these two casualties, I have avoided peritoneoscopy in patients with seriously reduced vital capacity and cardiac reserve and also in those suspected of generalized intra-abdominal adhesions. The mere presence of previous laparotomy scars, however, does not necessarily contraindicate peritoneoscopy.

	No. of Cases
Conditions involving the liver, such as cirrhosis, with or without ascites, carcinoma, etc.	34
Jaundice of uncertain etiology	6
Splenomegaly	2
Suspected intraperitoneal tuberculosis	4
Pelvic pathology	9
Carcinoma of the colon (deciding operability)	2
Differentiating between appendicitis and salpingitis	5
Gunshot and stab wounds of the abdomen of questioned penetration	12
Miscellaneous conditions, including undiagnosable abdominal tumors, suspected hemoperitoneum, intra-abdominal adhesions, etc.	6

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SUMMARY OF CASES

Since the commencement of this study in December, 1939, eighty observations* have been made upon seventy-five patients. The distribution of cases examined is as shown in the table on page 668.

Table 1 condenses the results of the eighty examinations. Sixty-eight times a problematic diagnosis was confirmed or changed, or new and significant information was added. Laparotomy was obviated seventeen times and was definitely elected in eleven instances when the indication for operation was in doubt. (Table 1.)

TABLE I

ANALYSIS OF EIGHTY PERITONEOSCOPIES

Diagnostic Problems		Deciding for or against Laparotomy		Other Uses
Clinical impression confirmed	38	Laparotomy avoided	17	Puncture of ovarian follicular cyst for uterine bleeding, 2 cases; one successfully accomplished, one failure due to inability to find the cyst.
Clinical impression changed	14	Indication for laparotomy decided	11	
Significant information added	16	Helped decide for or against operation	12	
Inconclusive*	12	No help in deciding for or against surgery†	9	
		Laparotomy not in question	31	

* Of these unsatisfactory results, eight occurred among the first sixteen peritoneoscopies performed with a foreoblique cystoscope. In still another case, before the biopsy forceps were acquired, syphilitic cirrhosis of the liver was missed. Twice among the earlier examinations the instrument could not be introduced into the abdominal cavity.

† Of these, seven followed as a result of "inconclusive" peritoneoscopic diagnoses. In another of these cases, scoped before the biopsy forceps had been procured, it could not be made certain by vision alone, whether masses in the liver were gummata or cancer.

NEW OR ONLY SLIGHTLY EXPLOITED APPLICATIONS OF PERITONEOSCOPY

There seems to be a prevailing opinion among writers on this subject that peritoneoscopy should not be used in any acute inflammatory or otherwise serious condition in which an adverse outcome might be blamed upon the instrumentation. Yet if peritoneoscopy in such a case can spare the patient the much greater procedure of exploratory laparotomy, and at the same time establish a diagnosis or decide whether or not operative intervention is necessary, it surely is indicated. If surgery should be found necessary, this preliminary procedure will not have added significantly in time or trauma to the operation. Some of the applications of peritoneoscopy about to be described will illustrate this.

Differentiation between Obstructive and Hepatic Jaundice. This differentiation is sometimes impossible in spite of all available diagnostic tests. Yet surgery is obligatory in the former case and contraindicated in the latter. Endoscopic visualization of the liver and gallbladder and biopsy of the former will, in the majority of these cases, make the diagnosis. Although this application in jaundice of doubtful etiology is doubtless tacitly assumed by most writers on peritoneoscopy, I have found definite reference made to it only by Olim[5] and Anderson.[8]

In the six cases of problematic jaundice in this series, the clinical impression was confirmed twice (hepatitis and cancer of the head of the pancreas).

In the third case, that of a twenty-six year old white female, the severity and type of abdominal pain, as well as a cholecystogram strongly suggestive of gallstones, made common duct stone a likely possibility. Finding a normal looking gallbladder and a liver normal in appearance except for some blunting of its margins

* The first sixteen peritoneoscopies were performed with a foreoblique cystocope, the remaining sixty-four with the Ruddock peritoneoscope.

pointed to a diagnosis of acute infectious or "catarrhal" jaundice. Absence of biliary symptoms and jaundice for over nine months confirms this impression.

The last case was that of a fifty-seven year old colored female suspected of having, on the basis of pelvic findings and enlarged, irregular liver, cancer of the cervix or uterus and obstructive jaundice from metastases. Through the scope a leiomyoma was found in the pelvis and a normal looking liver with dense adhesions around a gray, thick looking gallbladder. Peritoneoscopic diagnosis of common duct stone was verified at operation and the condition was successfully relieved.

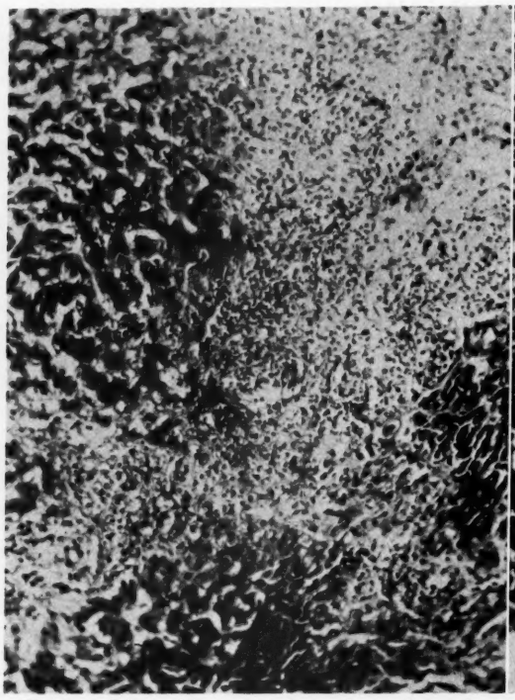

FIG. 1. Liver biopsy, taken through peritoneoscope showing probable syphilitic hepatitis.

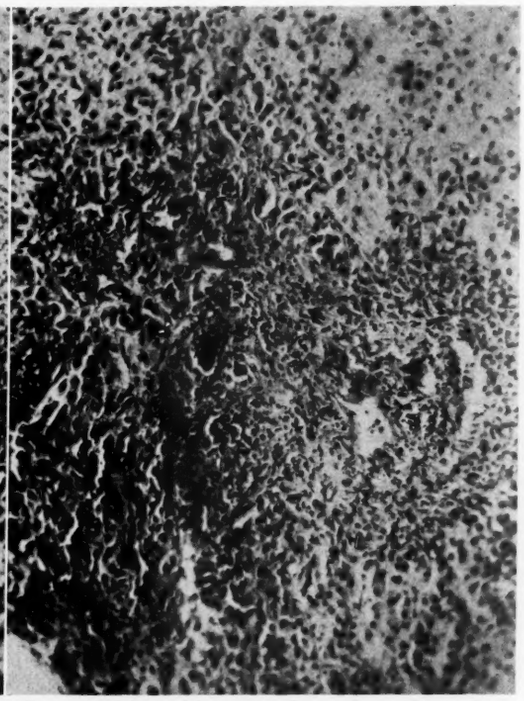

FIG. 2. Liver biopsy, taken through peritoneoscope showing bile obstruction, cholangeitis and early biliary cirrhosis.

Another patient, a thirty-seven year old female luetic who had been on arsenical therapy, was thought to have either arsphenamine hepatitis or infectious jaundice. Endoscopy and biopsy (Fig. 1) revealed syphilitic hepatitis.

The clinical impression of the fifth patient, an elderly man with painless jaundice, lay between cancer of the head of the pancreas and catarrhal jaundice. At peritoneoscopy a nondistended and apparently normal gallbladder rendered cancer of the head of the pancreas very unlikely. The liver was grossly not remarkable. A biopsy (Fig. 2) was reported, "Bile obstruction, cholangeitis and early biliary cirrhosis." The pathologist considered this compatible with the clinical syndrome of catarrhal or infectious jaundice and this diagnosis was further confirmed by the improvement and recovery of the patient.

Differentiation between Bleeding Peptic Ulcer and Ruptured Esophageal Varix. Surgical intervention is frequently indicated to control massive hemorrhage from peptic ulcer, especially in patients past fifty. In the occasional case in which cirrhosis of the liver with ruptured esophageal varix cannot be ruled out, visualization of the liver through the peritoneoscope should settle the diagnosis. This procedure, gently performed without even moving the patient from his bed, would seem to be less conducive to further hemorrhage and

more conclusive than the barium swallow recommended by Stalker and Gray[9] and others for diagnosing esophageal varices.

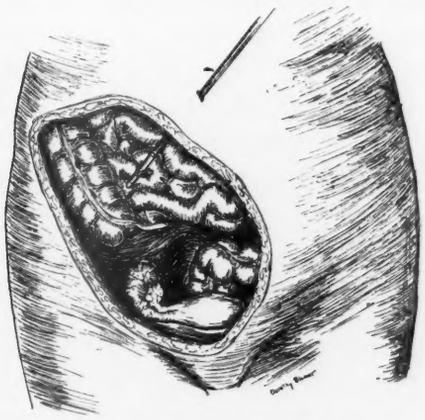

Fig. 3. Making the differential diagnosis between acute appendicitis and acute salpingitis. The appendix is normal, the right tube acutely inflamed and swollen.

Two cases of massive hematemesis admitted to our service this past year illustrate this point. The first patient, operated upon for bleeding peptic ulcer, was found to have a cirrhotic liver. Peritoneoscopy would have spared this patient an operation. In the second, a similar case, preliminary peritoneoscopy revealed a typical hobnail liver, thereby eliminating any question of laparotomy.

Differentiation between Appendicitis and Salpingitis. In this group were five patients in whom the diagnosis lay between acute appendicitis and acute salpingitis. Finding normal tubes by peritoneoscopy would demand operation unless the appendix could be satisfactorily visualized as normal. Discovering acutely diseased adnexae, on the other hand, would make the diagnosis of salpingitis and obviate surgery.

The first patient was admitted while a cystoscope was still being used for peritoneoscopy, and was one of two cases in which the instrument could not be introduced into the abdominal cavity. Exploratory laparotomy immediately following the unsuccessful attempt revealed little of pathology, either in the appendix or tubes. The operation and convalescence were without mishap.

The next three cases were completely successful. In two, a normal appendix and acutely inflamed adnexae were visualized.

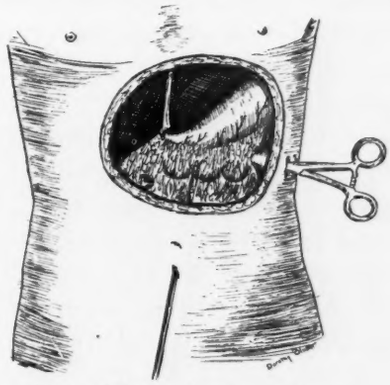

Fig. 4. Illustrating how a hemostat, poked through the suspected stab or gunshot wound, will indent and localize the underlying peritoneum for inspection through the peritoneoscope.

(Fig. 3.) In the third, although the appendix could not be seen, the diagnosis was settled by finding acute inflammation of the salpinx.

When the scope had been introduced into the fifth patient, free grayish purulent exudate was found, both in the pelvis and also in the cecal region and extending up in the right paracolic gutter. The right tube was only moderately injected and swollen, the right ovary normal. The main inflammatory process appeared to be in the region of the cecum, where there were plastic adhesions and what appeared to be the swollen base of the appendix with the remainder well walled off beneath loops of ileum. The patient was placed on the Ochsner regime and her recovery was uneventful. An interval operation four months later revealed a deformed, obliterated appendix with confirmatory microscopical evidence of previous inflammation. Tubes and ovaries were not remarkable. Although this patient would not have been peritoneoscoped if appendiceal peritonitis had appeared likely, the procedure in this case not only caused no harm, but obviated a laparotomy in the presence of peritonitis.

Ruling Possible Penetration in or out in Abdominal Gunshot and Stab Wounds. I have discussed this application of peritoneoscopy in a previous paper.[10] In 12 to 15 per cent of explorations for gunshot or stab wound of the abdomen the findings are negative. Peritoneoscopy can, in practically all cases, answer definitely the question of penetration of knife or bullet and thereby eliminate a number of needless operations. Figure 4 demonstrates how this is done. If the parietal peritoneum is intact, laparotomy is obviated; if a perforation is found, laparotomy follows. So far, peritoneoscopy has been performed in twelve cases of questioned abdominal penetration (nine stab wounds and three gunshot wounds) and in every instance has proved the presence or absence of penetration. Since penetration was present in only five cases, laparotomy was rendered unnecessary in the other seven. In one other patient with a gunshot wound, fluoroscopy revealed that the bullet had lodged in the right lobe of the liver, but it could not be determined whether or not active hemorrhage was present. Through the scope the absence of hemoperitoneum was assured.

Eleven of the above thirteen patients left the hospital without incident; the other two succumbed as a result of their injuries.

In the first of these, the bullet had passed through the lower chest and liver and had caused extensive hemoperitoneum. The patient progressed satisfactorily until the third postoperative day at which time the laparotomy wound disrupted. This accident was followed by bronchopneumonia, paralytic ileus and exitus on the eighth postoperative day.

Operation in the second case revealed perforation of the left femoral artery and vein as well as of three loops of jejunum. Death came the second postoperative day as a result of pulmonary embolism.

Rupture of Follicular Cysts of the Ovary for Uterine Bleeding. Twice in women unsuccessfully treated for uterine bleeding by hormone therapy and curettage, rupture of clinically diagnosed follicular cysts of the ovary was undertaken through the scope as a last resort before surgery. It was reasoned that this procedure might remove an excessive hormonal stimulus for bleeding. In the first case a small cyst of the right ovary was overlooked and the patient subsequently underwent hysterectomy.

In the second woman a retention cyst in the left ovary 8 cm. in diameter was punctured and 2 ounces of straw-colored fluid escaped. For six months her previously severe and prolonged menorrhagia gave place to scanty flow and occasional "spotting," and the endometrial biopsy, which previously had shown hyperplastic endometrium, now revealed anovulatory, hypoplastic endometrium. The patient was so well pleased that when the flooding recurred after the six months' respite, she returned for further treatment. Re-examination through the peritonescope revealed complete absence of the previous cyst and small sclerosed, hypoplastic-looking ovaries on both sides. A last trial with a new lactogenic hormone is being made before resorting to hysterectomy.

This last application is included merely as a suggestion for cases of intractible uterine bleeding before more radical procedures are employed. Further trials are contemplated as properly selected cases present themselves.

SUMMARY

Eighty peritoneoscopies upon seventy-five patients with a variety of conditions are summarized.

The following applications of the peritoneoscope, either new or little exploited, are presented: (1) Differential diagnosis of jaundice; (2) differentiating between bleeding peptic ulcer and ruptured esophageal varix; (3) differentiating appendicitis from salpingitis, (4) deciding whether or not gunshot and stab wounds of the abdomen are penetrating, and (5) rupture of follicular cysts of the ovary in women with

uterine bleeding and in whom other measures short of surgery have failed.

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IN simple uniform goiters of adolescence all the acini contribute to the increase in the size of the gland by increasing their colloid content equally. The result is an equitable increase of the gland in all its parts.

HEALING OF THE OPERATIVE WOUND IN SYPHILITIC WOMEN*

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UNTIL recently, comparative studies in the postoperative course and progress of wound healing in the syphilitic and nonsyphilitic patient has had a limited statistical approach. It was the general belief that the syphilitic patient was a poor surgical risk and that the operative wounds of these patients were prone to delayed union.[1] It has also been generally accepted that these undesirable features in the surgical syphilitic person could be avoided by the use of pre- and postoperative antisyphilitic treatment.[2]

Menninger,[3] in 1925, studied twenty-two surgical cases with strongly positive Wassermann reactions. He concluded that preoperative treatment is desirable and postoperative treatment advisable, although the effectiveness of such treatment as an aid to wound healing is undetermined.

In the same year, Goeckerman[4] presented a study of seventy-eight cases with syphilis, fifty of which had received treatment, twenty-eight none. He concluded that treated syphilitic patients could be operated upon with impunity and that old syphilitic patients were poor surgical risks only in proportion to the tissue damage.

Scheffey,[5] in 1931, studied ninety-two cases with positive and ninety-two cases with negative Wassermann reactions. He found that there was practically no difference in the wound healing between the positive and negative groups.

In 1940, Philip[6] reported a series of 164 patients operated upon; eighty-three of these had old syphilis and eighty-one had no evidence of the disease. All the syphilitic cases received six injections of salvarsan before operation. It is noted that even though these syphilitic patients were treated, they still showed 9.4 per cent more wound infections than the nonsyphilitic patients.

In this study, 4,717 cases, admitted to the Gynecological Service of the Harlem Hospital were reviewed. A Kahn test was done in 2,815 cases; it was positive in 1,111 (39.4 per cent) and negative in 1,704 (60.6 per cent).

Of the total 4,717 cases, 1,603 consecutive laparotomies were performed. The great preponderance of operations was for pelvic inflammatory disease and fibromyomas; the remainder for ectopics, ovarian cysts, tumors and pregnancies in tubercular patients.

From this group of 1,603 laparotomies, 930 cases that fitted the following criteria were selected for study: (1) Each case had a blood Kahn test made; (2) each case had a laparotomy performed for a gynecological complaint. No other surgery, except appendectomy, was performed at the same time. (3) At the time of operation no patient showed signs or symptoms of primary or secondary syphilis. (4) No patient received immediate pre- or postoperative antisyphilitic treatment. (5) Operations in which intra-abdominal or skin drains were used, were excluded. (6) No syphilitic lesions were incised at the time of operation.

As a rule the history and physical examination were not sufficient to make the diagnosis of syphilis. Therefore, what has actually been done is to make a study of the operative wounds in patients with positive and negative Kahn tests.

* From the Gynecological Service of Harlem Hospital, New York City.

Of the 930 selected laparotomies, 450 gave Kahn positive and 480 Kahn negative reactions. In the positive group of 450, fifty-four (12 per cent) had a one plus reaction. To be accurate these tests should have been repeated. However, according to Kolmer[7] a faintly positive Kahn reaction should be considered the first link in the chain of syphilitic diagnosis. Therefore, these fifty-four cases were considered to be positive in this series. It is hoped that the weakly positive cases that were actually negative and the negative results in chronic syphilitic patients would statistically cancel each other.

Table 1
Postoperative Wound and the Kahn Test

	Positive Kahn (450 Cases)		Negative Kahn (480 Cases)	
	No.	Per Cent	No.	Per Cent
Normal wounds	363	80.6	399	83.1
Collection of serum	7	1.55	10	2.08
Infections	74	16.4	61	12.9
Dehiscence	2	0.44	2	0.41
Eviscerations*	1	0.22	5	1.01
Fecal fistulas	3	0.66	3	0.61

* In the entire group of 1,603 laparotomies there were eight eviscerations. The presence of six eviscerations in the 930 selected cases may be misleading, if the complete group of 1,603 is not considered. Five of the six cases of evisceration occurred within a short period of time (three months) and were probably due to faulty technic.

In the 930 selected cases, other systemic diseases co-existent with the syphilitic infection, included tuberculosis, diabetes and rheumatic fever. This group is not large since practically all these operations were elective, and operation was avoided where serious systemic disease was present.

Preoperatively, all cases had complete physical examinations, weekly urine examinations, complete blood counts, sedimentation rates and blood pressures. A Kahn test was done routinely on admission.

Patients who had pelvic inflammatory disease were not operated upon until Simpson's rules were fulfilled, that is, a two-week period had elapsed during which time the temperature was normal, the blood count normal and the sedimentation rate within normal limits. In the Harlem Hospital Gynecological Clinic, operations were performed on patients with pelvic inflammatory disease who had a sedimentation rate of 18 mm. in one-half hour. This is a shorter time than most clinics employ and may be a factor in the fairly high incidence of infection that appears in Table 1.

Analysis of the Seventy-four Wound Infections in the 450 Patients with a Positive Kahn Test

Duration in Days	No. of Cases
1–5	31
6–10	17
11–15	7
16–20	6
21–25	1
26–30	3

Dehiscence—2 Cases, one a reoperative case, and one an uncomplicated supracervical hysterectomy.

Eviscerations—1 Case, this occurred on the ninth day following an operation for fibroids, intraligamentous cyst and numerous adhesions.

Fecal Fistulas 3 Cases.

1. Fifteenth day—case with adhesions between sigmoid and uterus, ovarian abscess opened at operation, no drainage.
2. Twenty-second day—fundectomy done on patient with pulmonary tuberculosis, postoperative peritonitis.
3. Ninth day—case with ileum adherent to a tubo-ovarian abscess. Serosa of ileum sutured. (Cases 1 and 3 both should have had abdominal drainage. These were probably errors in surgical judgment.)

Analysis of Sixty-one Wound Infections in the 480 Patients with a Negative Kahn Test

Duration in Days	No. of Cases
1–15	16
6–10	21
11–15	14
16–20	7
21–25	1
26–30	1

Dehiscence 2 Cases.

Eviscerations 5 Cases.

1. Seventh Day—hysterectomy and postoperative diabetic coma.
2. Fifth Day—fibroids with excess ascitic fluid.
3. Eighth Day—fibroid uterus, chronic salpingitis and hemorrhagic cyst of the ovary.
4. Fourth Day—intraligamentous cyst removed.
5. Tenth Day—appendectomy in patient with intra-uterine pregnancy.

Fecal Fistulas 3 Cases.

1. Ninth Day—case with adhesions between uterus and adnexae; adhesions separated, pus spilled from abscess.
2. Ninth Day—case with numerous adhesions in a "stony hard pelvis"; hysterectomy and salpingectomy done.
3. Patient operated upon in November, 1935; discharged as cured with no fistula; re-admitted to the hospital in April, 1936, with a fecal fistula.

DISCUSSION

From these charts the following facts are noted:

1. In this series, as well as in those of other authors, Scheffey, Goeckerman and Philip, the incidence of wound infections is slightly higher in the group of cases with positive Kahn reactions than in the negative Kahn cases. The slight differences noted, however, are of questionable statistical significance. There is little difference in the severity of the infections in the two groups, as measured by the duration of the infection and the length of the hospital stay.

Fecal fistulas were of equal numbers in both groups, and were caused in most instances by the separation of adherent loops of gut, postoperative peritonitis or the escape of pus into the peritoneal cavity. In several of the cases that developed fecal fistulas, poor surgical judgment was used in that indicated abdominal drainage was not employed.

2. Of the patients admitted to the Harlem Hospital Gynecological Service, approximately 91 per cent are negroes. Therefore, the 450 laparotomies studied, were done largely on negroes who had a positive Kahn test with asymptomatic syphilis. The problem, as to whether or not asymptomatic syphilis in the negro surgical patient takes a more benign form than in the white patient, requires careful consideration. If this is true, it may explain the wide difference between the statistics presented by Menninger, Philip and others, and the series of cases here presented.

3. No preoperative antisyphilitic treatment was given in the cases reviewed. In figures presented by other authors, in which immediate preoperative antisyphilitic treatment was given, the percentage of wound infections was greater in the Kahn positive group than it was in our series of untreated syphilitic cases. It has been our opinion that there is reactivation of a dormant syphilitic infection when insufficient preoperative treatment is given. A limited number of patients were treated and the results lead to the conclusion that antisyphilitic treatment should not be carried out preceding the operation, unless a full course of treatment is given. All positive Kahn cases are referred for treatment, after discharge, to the Syphilitic Clinic.

CONCLUSIONS

1. In 4,717 admissions to the Harlem Hospital Gynecological Service, the Kahn test was done in 2,815 cases and was positive in 1,111 or 39.4 per cent.

2. Nine hundred thirty consecutive laparotomies that fitted certain criteria were reviewed. In 450 of these cases the Kahn test was positive, and in 480 it was negative.

3. In the Kahn positive group, the percentage of wound infections was 16.4 per cent. In the Kahn negative group it was 12.9 per cent.

4. Eviscerations and fecal fistulas had no apparent relation to the presence of syphilis.

5. The presence of latent syphilis, treated or untreated, presented a slight additional risk as far as wound healing and morbidity were concerned.

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Goiters in children show certain similarities and differences which in a measure distinguish them from goiters in the adult. As is so often true with the diseases of childhood, goiters in children appear in the simplest form, uncomplicated by other diseases; and, particularly important in the study of goiter, they are uninfluenced by emotional states.

CONGENITAL DUODENAL OBSTRUCTION

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CONGENITAL anomalies of the intestinal tract are frequently encountered by pediatrists, roentgenologists and surgeons. In reviewing some of the literature written on this subject, the writer finds a great number of articles on malrotation of the mesentery, atresias and congenital bands which are the most frequent causes of congenital duodenal obstruction and also obstruction at various levels of the intestinal tract.

Since these abnormal conditions affect the intestinal tract at various levels and often in multiple sites, particularly in babies, every case encountered is a problem of absorbing interest. Although the final results in the treatment of these malformations are discouraging in a high percentage of cases, one should always entertain the hope that such obstructions may lend themselves to correction by relatively simple or safe surgical procedures. According to Webb and Wangensteen the first case of intestinal malformation was reported by Calder in 1773.

Simpson suggested faulty development of the sympathetic nervous system of the gastrointestinal tract as a cause of congenital anomalies. Segmental arrest of developmental accidents, such as intussusception or volvulus, failure of development of, or decrease in sufficient blood supply to certain segments, and fetal disease, such as peritonitis or localized enteritis, were also enumerated by him as theories.

Haymond and Dragstedt divide the process of intestinal rotation into three stages:

"During the fifth and tenth week of intrauterine life while the mid gut lies in the umbilical cord, the intestine increases rapidly in length forming an S-shaped flexure.

"The second stage is completed by the tenth to the eleventh week as the mid gut is returned to the abdominal cavity and the cecum reaches the right groin.

"The third stage is concerned with the fixation and fusion of the various portions of the intestine in their adult position."

Since Ladd published a series of cases successfully operated upon for malrotation of the small intestine in 1932, many authors have reported instances of this anomalous condition corrected by the method described by him which consists of untwisting the volvulus and severing the extrinsic bands attached to the upper jejunum and terminal ileum.

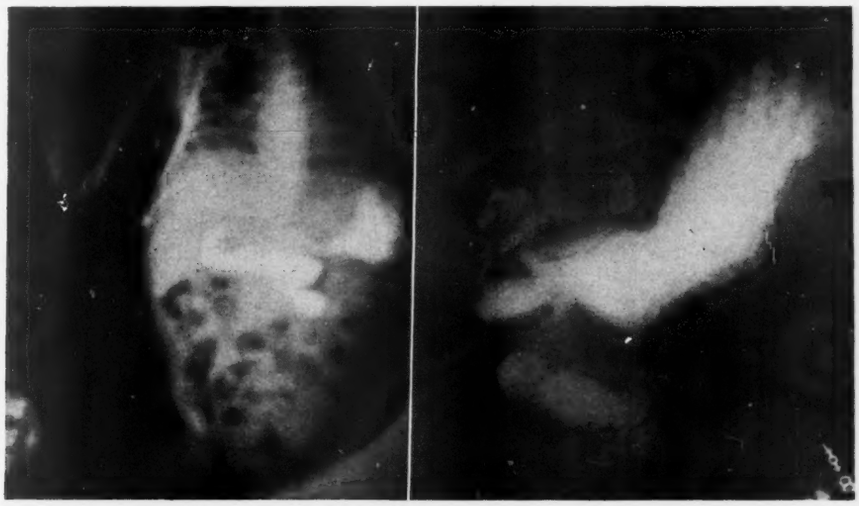
Elam reported three cases of duodenal obstruction due to an entire volvulus of the small intestine and congenital bands occluding the upper jejunum and terminal ileum. He expressed the belief that the defect was a failure in the third stage of intestinal rotation associated with an attachment of the terminal ileum to the upper jejunum in the left upper abdomen. All three of his patients were cured by carrying out Ladd's procedure.

CASE REPORTS

CASE 1. Baby R. T., male, aged six weeks, was admitted to Sternberger Children's Hospital on the pediatric service of Dr. M. Y. Keith, with whom the writer saw the patient in consultation on November 5, 1934. The child was markedly undernourished and extremely dehydrated. Although this baby was normal at birth, and weighed nine pounds when he began to vomit on the tenth day, his weight had varied during the periods of vomiting and periods of relief until it had decreased to six pounds and three ounces at the time of admission. Obstipation was associated with these attacks of vomiting, no results being obtained with laxatives or with enemas. The vomitus

consisted of food which had been taken from a few minutes to three or four hours previously. It was frequently bile-stained.

jejunum several dense bands of adhesions were found constricting the intestine. Upon division of these bands a loop of distended jejunum was



A B

Fig. 1. A, *x*-ray photograph before operation; B, film made nearly six years after operation.

After sufficient parenteral fluids in the form of Hartmann's solution and transfusions of blood had been administered, a gastrointestinal study was made by Dr. B. E. Rhudy. During this study the stomach and duodenum were found greatly dilated, the barium stopping abruptly in the duodenojejunal area. Serial plates, however, showed that some of the barium passed through this constricted area into the lower small intestine but much of it was regurgitated and a considerable portion of the meal remained in the stomach at the end of six hours.

Following this *x*-ray study, apparently as a result of the heavy material ingested, the baby ceased to vomit and began to have fairly normal bowel movements. Because of this improvement in the patient's condition he was allowed to leave the hospital.

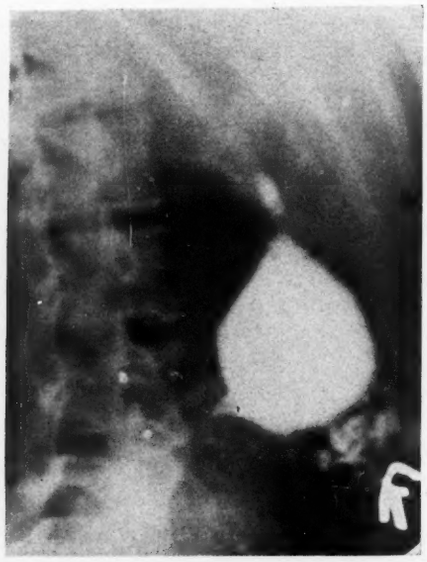
Two weeks later, however, the vomiting and obstipation recurred, resulting in a very rapid loss in weight and strength with marked dehydration. At this time he weighed only six pounds and twelve ounces. *X*-ray studies again showed definite obstruction in the duodenojejunal area which is seen in the accompanying *x*-ray photograph in Figure 1.

After the usual preoperative measures, an exploratory incision was made with the following findings: The stomach and entire duodenum were greatly enlarged and distended with gas. At the junction of the duodenum with the found herniated into the supraduodenal fossa with constriction of both barrels of the loop by the bands, causing an almost complete obstruction. When these bands of adhesions were divided the loop was released. Following this procedure there was distention of the jejunum below this point.

In the region of the lower ileum, however, the mesentery was found twisted, was approximately one inch thick and contained veins as large as a lead pencil; this, with a brawny color to this portion of the gut, suggested an obstruction to the return flow in these vessels. Evidently this was a result of a fixed mesentery which had failed to rotate. A portion of the ileum passed under this thickened mesentery and, although it could not be readily traced, it appeared partially obstructed by thick bands of adhesions above the point of entrance and at the exit where it tunneled under the mesentery. It was not possible to rotate the mesentery because of its fixation to the posterior abdominal wall. The cecum and appendix were in the normal position.

At this stage of the operation the patient ceased to breathe but after stimulants were given and the hugely dilated stomach deflated by knife puncture respiration was resumed. His condition continued to improve and he left the operating room in fair condition.

With the exception of one period of vomiting, obstipation and formation of a fecal impaction



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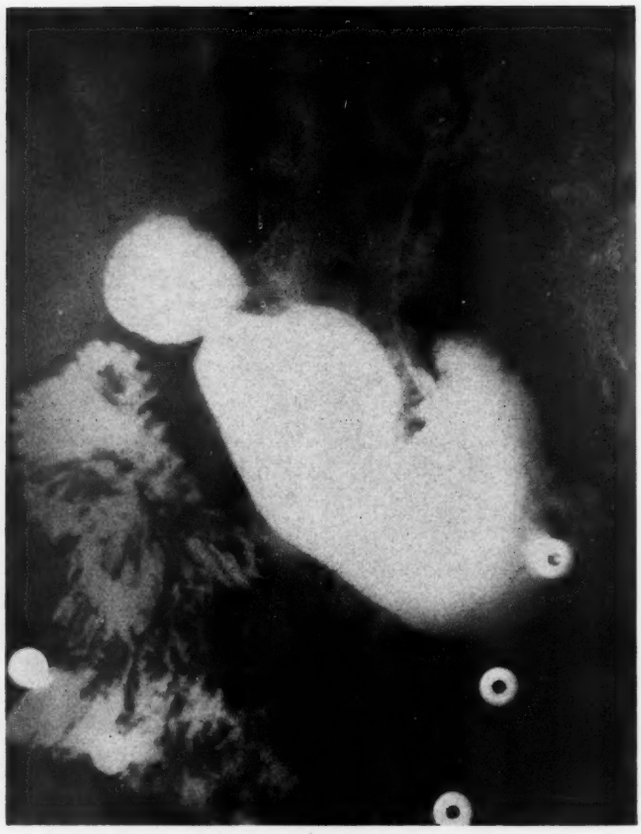

B

FIG. 2. A, film taken seven hours following a barium meal before operation; B, *x*-ray three and one-half months following operation.

a few days after operation, convalescence was normal. At the present time, July, 1940, this patient is robust and apparently well, having been free from any gastrointestinal disturbance since his discharge from the hospital.

Case II. C. F., male, aged twenty, was admitted to the Wesley Long Hospital on April 5, 1940, because of empyema and attacks of vomiting. The empyema resulted from a lower left lobectomy for infected congenital cysts of the lung.

Since the age of ten he had suffered with occasional attacks of heartburn, sour stomach, eructations and periods of persistent vomiting. Although the heartburn was relieved by soda, there were no other symptoms suggestive of peptic ulcer. For the past six months these attacks of vomiting lasted from one month to six weeks.

Upon examination he was found to be dehydrated, emaciated and weighed about seventy-five pounds. The empyema was satisfactorily drained but vomiting of all food continued.

X-ray examination by Dr. E. D. Apple showed an obstruction of the descending loop of the duodenum. The stomach was low and atonic.

Following the usual preoperative preparation, abdominal exploration was performed April 24, 1940. The duodenum, in its first and second portions, was about two inches in diameter. Because of the patient's precarious condition it seemed unwise to attempt exposure of the third portion of the duodenum which contained the obstructive lesion. The duodenojejunal angle was not involved. Therefore, a posterior duodenojejunostomy was performed, following which an uneventful convalescence ensued. Complete relief with a rapid gain in weight followed this procedure.

DISCUSSION

In one of the cases cited in this paper there was an apparent malrotation of the small intestine but the peritoneal attachments were so firm and the mesentery so short or absent in the lower ileum that untwisting was not possible. However, this congenital defect evidently did not interfere seriously with the lumen of the lower ileum since no further symptoms of obstruction have occurred within a period of six years following the operation.

The nature of the obstructing lesion in the second patient is not known. Although it is possible that contraction from an old ulcer in the third portion of the duodenum may have been the cause of obstruction, no definite ulcer symptoms could be obtained. Both the history and location of the obstruction lead the writer to believe that the obstruction in this patient was due to a congenital lesion.

SUMMARY

Two cases of upper intestinal obstruction are presented. In one patient there is no question but that the obstruction was of congenital origin because of the findings at operation and the fact that the symptoms dated back to within ten days of birth. Also, other congenital anomalies of the intestinal tract with arrested rotation of the mesentery were found at operation. In the second case there is much evidence that the obstruction is also of a congenital nature because of the history and the fact that this patient had congenital pulmonary cysts which required lobectomy.

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POSTOPERATIVE EVISCERATION*

A RÉSUMÉ OF THE LITERATURE AND REPORT OF FIVE CASES

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OUR interest in wound disruptions was stimulated by the occurrence of five cases on the gynecological service of Harlem Hospital within a two-month period. These were the sole disruptions observed in 1,543 consecutive laparotomies during a three-year period. Many terms have been used in the literature for this condition such as, (a) postoperative evisceration, (b) dehiscence of abdominal wound, (c) broken-down abdominal wound and (d) postoperative rupture. This paper is concerned only with those in which there were actual protrusion of the intestines or omentum.

A study of the literature shows that the suggested etiological factors may be grouped as follows: (1) *Increased intra-abdominal tension;* (2) *faulty technic,* (a) faulty material, (b) improper closure of peritoneum, (c) drainage, (d) type of incision, (e) factors attributed to the surgeon; (3) *metabolic disturbances,* (a) diabetes, (b) malignancy, (c) syphilis, (d) other maladies with toxemia, (e) nutritive anemis, and (4) allergy. Most writers consider evisceration to be due to a combination of factors rather than to one single cause. Their theories will be considered under the heading upon which they lay most stress.

INCREASED INTRA-ABDOMINAL TENSION

Milbert agrees with Freeman, that emphasis on the etiological importance of age, sex, seasonal incidence, primary illness and allergic phenomena is "begging the question." Disruptions represent a failure of the suture line to hold, whether due to suture material or to abuse, with associated increase in abdominal pressure. Without the factor of excessive intra-abdominal pressure, an inherently weak wound might escape disruptions.

In a series of 7,892 laparotomies, H. Koster and L. R. Kossman believed that cough causing increased abdominal pressure was a disruptive factor in fourteen of the seventeen cases. Glasser states that in 3,234 laparotomies increased intra-abdominal pressure was the primary factor in eight cases of evisceration.

Many investigators have attributed evisceration to increased abdominal tension. Cough, (Koster), distention, (Colp), hiccough and sneezing, (White), all of these raise intra-abdominal pressure and place a strain upon the suture line. Patients (Jenkins) who are delirious or unruly, who get out of bed shortly after operation, who thrash about, who are difficult to control while coming out of anesthesia all put an undue strain on the incision. Two instances of audible breaking of the suture under such circumstances have been reported by Ries.

FAULTY TECHNIQUE

1. *Faulty Material.* The controversy of absorbable versus nonabsorbable sutures arises quite frequently in discussions regarding the prevention of postoperative evisceration, however, disruptions have been found to occur regardless of whether wire, linen, silk, silkworm or catgut is used. Reis has had an excellent record in a limited series of cases in which he used silver wire to close the abdomen of patients whom he considered potential candidates for disruption. The same technic in the

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hands of others has not been without mishap. The advocates of the silk technic state that silk is less likely to result in disruption than catgut. The majority of the cases with disruption (275) reported by Sokolov followed the use of silk. Linen offers no guarantee against disruption (Jenkins).

Since there is no legal standard of catgut gauge and strength in the United States, most companies have adopted the Federal specifications* as their standard:

The holding power of the suture is dependent on the tensile strength of the suture and the strength of the tissue in which it is placed. It is only in fascia that the holding power of tissue is greater than the strength of the finest catgut. (Fig. 1.)

Howes and Harvey did experiments on animals to determine these factors. Some of their conclusions were as follows:

* Catgut ligature shall be contained in tubes made of transparent clean glass tubing of good quality and uniformity of wall material. Tubes when sealed, shall measure 95 to 110 millimeters in outside length and from 10 to 12 millimeters in diameter. Each tube shall have engraved at or near its center an encircling fracture mark of proper depth to enable the tube to be broken evenly at the fracture mark without undue twist, introduced in the tube in a manner to allow the top loop of the coil and the fracture mark to facilitate removal of ligature. Each tube shall contain one strand of sterile catgut ligature in the tubing fluid specified.

"Each tube shall contain a sufficient amount of tubing fluid to cover completely the coiled catgut when the tube is held in vertical position.

"This tubing fluid shall be stable under sterilizing tests as described below, non-toxic and anhydrous and shall contain no substance which will have a deleterious effect upon the breaking strength of the ligature, even after the ligature has been stored for an indefinite period. The breaking strength of the catgut shall be determined immediately after autoclaving the tube for thirty (30) minutes at 120°C.

"Each carton containing tubes of boilable catgut ligatures shall be plainly marked with the manufacturer's control (lot) number, in order to identify the lot in the manufacturer's original and permanent record of sterilization, and such records shall be open to government inspection."

This specification has no legal status but it is the specification which is followed by the various agencies of the Federal Government in the purchase of catgut.

The function of a suture is to hold tissue in position until the healing of a wound makes such artificial support unnecessary. When this purpose has been accomplished, the material employed should be absorbed and if not absorbed should be inoffensive.

Table 1
FEDERAL STANDARD STOCK CATALOG

	Nominal Diameter Inch				Breaking Strength	
	Millimeter		Inch		Minimum on a Straight Pull	Pounds over a Reef Knot
	Minimum	Maximum	Minimum	Maximum		
00	0.229	0.305	0.009	.012	4	2.8
0	.305	.381	.012	.015	7	4.9
1	.381	.457	.015	.018	10	7.0
2	.457	.533	.018	.021	13	9.1
3	.533	.609	.021	.024	20	11.2
4	.609	.685	.024	.027	..	14.0

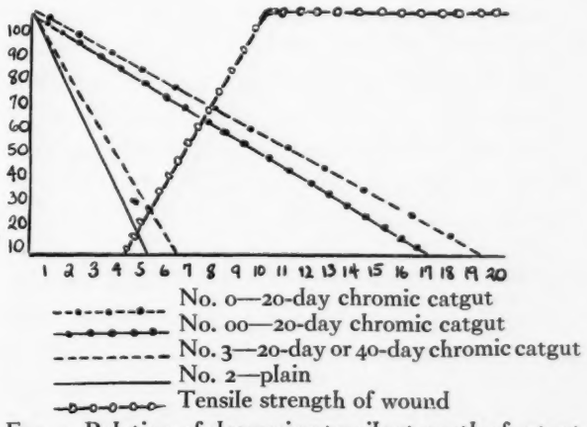

Fig. 1. Relation of decreasing tensile strength of catgut to increasing tensile strength of wound. (Modification of graph by Howes and Harvey.)

1. There is a "lag period" of between four and five days, when the strength of a wound is merely that of the fibrinous adhesions on the surface of the wound. The tensile strength of a wound which is a measure of the proliferation of the fibroblasts begins to rise abruptly at the end of this time and approaches the maximum strength of a wound in ten to twelve days.

2. The relation of the decreasing tensile strength of catgut to the increasing tensile strength of the wound is shown in Figure 1.

3. Catgut, being a foreign body, even in small amounts, causes some degree of reaction in the tissue in which it is embedded. It possesses an advantage over nonabsorbable sutures in that it is capable

of digestion and by this process ultimately disappears.

4. When infection is present or occurs during the healing of a wound, the digestive process is intensified so that the gut, irrespective of the degree of chromatization, rapidly disappears, with an early loss of healing power. Under the same circumstances the nonabsorbable suture acts as a persistent nidus of infection which eventually leads to its extrusion.

5. The chromic catgut of one manufacturer showed complete loss of tensile strength within six days, regardless of size or whether it was of the twenty or forty-day variety, emphasizing the importance of knowing the material being used.

6. Foreign bodies and flaws in many brands of catgut are found apparently due to splicing of the catgut and to bending of brittle "boilable" catgut in narrow glass tubes (Kraissl). These imperfections appreciably alter the rapidity of loss of tensile strength.

Harvey and Howes have shown that the tissue reaction is in proportion to the amount of catgut used. Therefore, the least amount of gut necessary to hold the approximation of the tissues until the wound gets sufficient strength to take over should be used. A comparison of the velocity curve* of the healing wound and the curve of the disappearance of catgut embedded in tissue, shows No. 0 twenty-day chromic catgut satisfies all requirements of the stitch in fascial and connective tissue layers. Even finer gut than this is sufficient for those structures in which the holding power of the stitch is less.

Bowen* also states that the use of finer grades of catgut is advantageous, although nonabsorbable sutures in selected cases are advised.

Wolff and Priestly in their investigation of the absorption of catgut in the human found this: (a) Contrary to the general belief, drainage and suppuratory wounds do not cause early absorption of catgut. (b) Individual variations in the absorption time of catgut occur normally. (c) Certain brands of catgut consistently last longer than other brands. (d) Small sizes of catgut last as long or longer than large sizes. Single strands of catgut last as long as double strands. (e) Labels indicating the length of time necessary for absorption of catgut are entirely fallacious insofar as the human being is concerned.

Improper Closure of Peritoneum. Freeman in pioneer experimental work, demonstrated that faulty technic can adequately produce evisceration in the absence of other factors. An omental plug is wedged into a gap of the suture line of the peritoneum and gradually works its way out. Thus a rupture occurs from within outward. Since peritoneum seals over within a few hours, the process of evisceration must begin soon after operation. This leads one to believe that a careful closure of the peritoneum prevents evisceration, although Jenkins believes that omentum is more protective than causative.

A variety of factors resulting in improper peritoneal closure and escape of the omentum plug have been suggested: (1) Infection, (2) improper hemostasis, (3) interposition of fat, (4) improper apposition of tissue planes, (5) tissue necrosis due to rough operation and mass ligation, (6) peritoneal sutures too unduly spaced, and (7) multiple perforations of the peritoneum due to improper relaxation, improper placement of sutures, etc.

Type of Incision. Many authors have suggested various types of incisions to avoid fascial and muscular strain on the healing wound, (Singleton and Blocker). However, eviscerations have occurred in every type of incision including McBurney,* although Boland states that lower abdominal incisions, particularly those in the midline are extremely susceptible to disruption.

Drainage. According to Colp, the incidence of disruption in drained cases is 1.22 per cent as compared to .84 per cent

* *Am. J. Surg.*, 47: 3, 1940.

* Maes, Boyce and McEstridge. *Am. Surg.*, 100: 968, 1934.

in undrained cases. Drainage often implies suppuration and, particularly if a continuous suture is used, early dissolution of the catgut may result in evisceration. Therefore, a separate stab incision or, if this is not feasible, interrupted sutures are advised. The presence of a drain enhances bacterial spread from the skin into the wound (Jenkins). In the emergency service at the Knickerbocker Hospital in New York City, it was the practice with bad appendices to suture only the peritoneum and posterior sheath. These patients healed very well and none eviscerated, although it has been repeatedly stated that infection hastens the rate of digestion of catgut sutures.

Mechanical Damage. The injury to a continuous catgut suture in the anterior sheath by the cutting action of a tightly made tension suture has been mentioned. The tightening up of a continuous suture with a needle holder or hemostat results in local damage to the catgut which not only weakens its tensile strength, but also renders the catgut more vulnerable to the digestive action of the tissue at the point of local damage.

Improper handling of boilable catgut by the operating room nurse alters its tensile strength. When this type of catgut is removed from the tube it is very brittle and nonpliable.

If catgut is extended without "wetting" there is likely to be some degree of fracturing at the point where it has been previously bent. On the other hand immersion into very hot water results in a marked decrease of tensile strength.

DISTURBANCES

It has been a common observation that elderly patients suffering from chronic sepsis, cachexia, malnutrition, vitamin deficiencies and particularly carcinoma are particularly prone to wound disruption (Colp, Jenkins, Grace, Whipple and Elliott). The knowledge of the biological and nutritional factors involved in wound healing is scanty, although it seems obvious that the above mentioned factors must play some significant rôle.

E. Von Graff reports four successive cases in which sugar tolerance tests revealed a diabetic condition. Greenhill was able to induce normal healing in a diabetic patient with an unhealed wound by the use of insulin. Contrary to their beliefs, Bettman and Lichtenstein found only six cases of cancer in thirty-two eviscerations. Boland observed that the incidence of evisceration in colored patients who were poorly nourished and often luetic was extremely low.

ALLERGY

J. Kraissl et al. have done interesting work concerning the relation of catgut sensitivity to a wound. They present evidence that sensitivity of the individual to one or more of the specific constituents of the suture material may be a cause of its premature absorption. In eleven animals sensitized to plain catgut, three disrupted their abdominal wound, two showed definite abnormal wound healing, while six healed normally. In the group of eight sensitized to chromic acid, three disrupted, three showed abnormal healing and two healed normally. These results are in marked contrast to the control animals in whom no disruptions and only one abnormal healing occurred. In a clinical study of thirty cases of wound disruption the following was found: (a) Catgut practically gone, chromic catgut disappeared; (b) of five patients who disrupted and who had a history of allergy, all showed evidence of sensitivity, while 52 per cent of those who gave no history of allergy gave immunological evidence of allergy.

Grotia and Gilson and Tripp have reported cases of disruption in whom allergic response to catgut seems to be the primary factor. Frugoni, however, has attempted to disprove this theory.

L. S. Fallis has called attention to the marked seasonal incidence of dehiscence, this complication apparently occurring in

the winter and summer months. The clinical picture in the non-infected cases suggests a possible allergic reaction in his opinion.

In a series of 1,543 consecutive laparotomies on the gynecological service of Harlem Hospital, New York City, during a three-year period* there were five cases of postoperative evisceration.

Sex. These cases occurred on the gynecological service.

Age. The age varied from twenty-three to forty-five years. These cases occurred in the third decade of life. The average age was 34.6 years.

Age in Years	Number of Cases
23	1
31	1
36	1
38	1
45	1

Incidence. The incidence of disruption in this series was 0.3 per cent. The incidence compares favorably with those of various writers.

	Per Cent
Boland	0.28
Sokolov	2–3 (European statistics)
Bettman and Lichenstein	0.4
Koster and Kassman	0.22
L. S. Fallis	0.6
Compilation by Bowen	0.49

Incision. The incision in all the cases was a lower abdominal, left paramedian incision.

TABLE I

Case No.	Disease	No.
1	Ruptured ectopic	1
2	Uterine fibromyomas and fibromyoma with twisted pedicle	1
3	Exploratory laparotomy (uterine pregnancy—error in diagnosis)	1
4	Fibroid uterus, chronic salpingitis, hemorrhagic cyst of right ovary	1
5	Fibromyoma of uteri and intraligamentary fibroid	1

* The last three years have been chosen, because the same staff of operators were in charge.

TABLE II

OPERATIVE PROCEDURE AND DAY OF DISRUPTION

Case No.	Procedure	Day of Disruption
1	Right salpingectomy	Third
2	Supracervical hysterectomy	Fifth
3	Appendectomy	Eleventh
4	Supracervical hysterectomy with salpingo-oophorectomy and appendectomy	Ninth
5	Supracervical hysterectomy and removal of intraligamentary fibroid	Fifth

Previous History. One patient had an old stab wound of the abdomen. The other patients gave no history of previous operations, asthma or any form of allergy.

Season. All the cases occurred in the spring of the year.

Anesthesia. Avertin and ether inhalation anesthesia were used in all cases, except Case 1 for whom ether inhalation alone was employed.

Day of Disruption. These cases were prepared very carefully for operation and were in the hospital from ten to twenty-one days before operation. Case 1 was an exception, due to her condition of emergency as a ruptured ectopic.

LABORATORY DATA

Case No.	Age	R.B.C.	W.B.C.	Hg. Per Cent	Sed. Time	Bl. Sugar
1	31	2,910,000	24,000	55		
2	38	3,400,000	12,000	65	Normal	88
3	23	3,500,000	10,200	65	Normal	80
4	36	3,700,000	8,600	70	Normal	90
5	45	3,500,000	9,200	60	Normal	78

Case No.	Creat.	Urena N.	Urine	Kahn	Bl. Press.	Kidney Function
1	...	....	Neg.*	Neg.	56/40	
2	1.1	9.2	Alb.	Neg.	118/80	Good
3	1.2	15	Neg.	Neg.	104/74	Good
4	1.4	16	Neg.	Neg.	100/65	Good
5	1.1	8.2	Neg.	†	165/115‡	Good

* Emergency. Complete work-up could not be done.

† In testing kidney function, the Mosenthal, P.S.P. tests and blood nitrogen were done.

‡ This was on admission and came down to within normal limits before operation.

Any anemia was corrected before operation.

In these cases it is significant to notice the absence of any disturbed carbohydrate metabolism, malignancy or malady of a wasting nature. Although the percentage

of syphilis among our patients is quite high only one disrupted case was luetic.

Closure of Abdomen. The abdominal wound was closed in layers with continuous plain catgut No. 2 suture for the peritoneum, continuous chromic catgut No. 2 suture for the fascia, four retention sutures (nonabsorbable) placed on two rubber bolsters, one on each side of incision and the skin closed with michel clips. In Cases No. 3 and No. 4 the peritoneum was sutured with separate double sutures of fine chromic catgut No. 0-0.

Clinical Course. The average time of disruption was the sixth day. Case No. 2 disrupted on the third day and showed no postoperative abdominal distention. On the second day, her dressings were soaked with an ammoniacal smelling fluid. On the third day postoperatively the wound was found gaping apart and a wad of ommentum protruding from the upper angle of the wound. Upon seeing this, one cannot but think of Freeman's theory. In Case No. 2, that disrupted on the fifth day, a blood-stained fluid was noticed on the dressing on the third day postoperatively. This wound was inspected at this early date because of the severe pain of which the patient complained. Proper interpretation of this serosanguineous discharge would have made the diagnosis at this time. In Case No. 3, sneezing, coughing, vomiting and marked abdominal distention occurred. Gastric lavage was employed. On the sixth postoperative day the patient began to improve. At the time of disruption, the patient was apparently comfortable. This case disrupted at the latest date in this series, the eleventh day. In Case No. 4, evisceration occurred on the ninth day. Postoperative convalescence was uneventful, except for the complaint of pain in the site of the incision since the second postoperative day.

In case No. 5, which disrupted on the fifth day, the patient began to cough on the first postoperative day. The diagnosis of a postoperative pneumonia was considered. The patient was treated accordingly and began to improve. The abdomen remained soft. On the fifth day, the skin clips were removed. After supper that day, the patient vomited twice. One and one-half hours later she went into shock. Examination of the wound at this time, showed an evisceration. Whether the vomiting was due to the disruption or caused the disruption is speculative.

The most frequent symptom presented by these cases, was pain at the site of the abdominal incision. In one case, the patient felt "something give way" which subsequent observation of the wound confirmed. In four cases the presence of wound evisceration was first noticed when the dressings were changed and the wound inspected. In two cases, the presence of serosanguineous drainage on the dressings was the first suggestion of disruption. In two cases, the wound disruption occurred shortly after the removal of the tension sutures.

Abdominal tension was absent or negligible in four cases. The one case with abdominal distention eviscerated on the eleventh day, the latest date in this series, and then after the abdominal distention subsided.

Allergy. In all cases skin tests for catgut allergy were negative.

Operative Findings. At the time of disruption, none of the wounds showed any obvious signs of infection. In Case No. 2, careful inspection of the wound revealed the knot of catgut at the upper angle of the peritoneum and the knot of catgut at the middle of the wound. The lower half of the peritoneum which had been sewed with a separate strand of catgut was intact. In Case No. 3, the wound was clean and no catgut was seen. The upper half of the peritoneal wound was open and through it was protruding a loop of small intestine. The lower half of the peritoneum was well healed. In Case No. 4, the entire wound was disrupted and the intestines pushed out. The wound was clean, that is, no visible suppuration was present. No sign of the catgut sutures was

present. In Case No. 5, the middle portion of the wound was found gaping and the skin clips in this region open. Upon removing the remaining skin clips a wad of omentum, about 2 cm. square, was found protruding from the upper angle of the wound. Upon raising this omentum, several loops of small intestines were found occupying the entire area of the incision. The wound was apparently clean.

It is interesting to note that in this series of cases, all the eviscerations started in the upper half of the peritoneal wound.

In brief, an examination of the disrupted wound showed no gross infection, a total absence of catgut and apparent deficiency in peritoneal healing.

Diagnosis. Pink staining observed on the dressing of the wound, in greater or lesser amount, is the earliest and most characteristic sign of wound disruption. It has been observed as soaking through the overlying dressings into the covering sheets. The discharge which is peritoneal fluid should not be disregarded if an early diagnosis of disruption is to be made. Pain is the next most important symptom, especially if it is referred to the wound after a fit of violent coughing or vomiting. In the presence of either of these symptoms the wound should be carefully observed for wound disruption. If the skin is apparently healed, it may be opened for inspection. Although sudden shock or symptoms of intestinal obstruction have been said to occur, they were not observed in this series.

DISCUSSION

Freeman's theory of inaccurate closure of the peritoneum seems most plausible as the primary factor in this series of patients. It is well known that the peritoneum seals over in a few hours and is remarkably elastic tissue. It would seem that any suture material capable of holding the peritoneum together during this brief period would be sufficient to prevent evisceration, although it might not be sufficiently strong to prevent postoperative herniation. Suggestive findings were those of Cases 2, 3, 4 and 5.

The question of faulty sutures was considered immediately after the first evisceration. The entire stock of catgut sutures was replaced with a fresh supply. Following the occurrence of the third evisceration, the plain catgut suture for the peritoneum was changed to a double suture of No. 0-0 chromic catgut. However, two disruptions occurred following the change of technic. The technic employed was otherwise unchanged.

Even though there was no visible suppuration present in any wound, the possibility of a low grade or nonpurulent infection cannot be excluded.

The factor influencing disruptions seem largely attributable to the surgeon and his technic. Improper closure of the peritoneum with widely spaced sutures allows the immediate protrusion of a piece of omentum or gut through the peritoneum. Serum is thrown out by the ensnared omentum or gut which causes rapid digestion of the catgut and retards the fibroplasia in the healing wound. This is a direct cause of evisceration.

Knots, poorly tied, may unravel immediately after laparotomy, before the peritoneum has had a chance to seal over. The omentum or gut is pushed through, with a resulting beginning evisceration. When sutures are equally spaced on either side of the peritoneal incision, the peritoneum under a sudden strain may tear as a stamp tears along its perforations. The use of bulky catgut in suturing the peritoneum leaves a weakness at the needle puncture, which may tear when a sudden strain is exerted on the wound. Bulky suture material causes more severe tissue reaction with a resultant edema, which interferes with the mechanical healing of the peritoneum. The grasping of the peritoneum with large clamps causes a devitalized area at the site of clamping. A suture passed through such areas will tear out very rapidly, leaving a nidus for eviscer-

ation. It is preferable to use allis clamps which materially reduce this danger.

When a patient has a secondary suture of a disrupted wound and recovers, there seems to be no further interference with wound healing. This is quite remarkable, considering the fact that through-and-through sutures are usually used, which must result in less accurate approximation of tissue than the layer-to-layer method. There seems to be two probable explanations: (a) That the engorged, thickened omentum lying immediately beneath the peritoneum, acts as a shield; and (b) That the process of wound healing, the so-called "lag period" has been prolonged. However, by the time the secondary suture is done, this "lag period" is in its final stage and the process of healing continues uninterruptedly.

If the peritoneum is properly sewn, the catgut suture, unless it is fractured or abused, will have sufficient tensile strength to hold the peritoneum together during the short period of time necessary to seal it. It would seem that too much catgut, bulky or faulty, poor hemostasis and improper handling of the wound, would cause retarded wound healing. Under these circumstances increased intra-abdominal pressure and strain on the wound may result in postoperative herniation instead of evisceration.

The great majority of wound eviscerations even in patients whose pathological status is reported as conducive to this catastrophe, can be prevented by thorough application of the knowledge of wound healing. The careful and accurate approximation of the peritoneum which is paramount in the prevention of postoperative disruptions, entails the following: (1) The use of fine, round needles; (2) No. 00 plain or chromic catgut; (3) proper placement of stitches; (4) allis clamps to hold peritoneum in preference to heavy crushing clamps, and (5) application of tight abdominal binder, before patient leaves operating room.

SUMMARY

1. A résumé of literature shows that the cause of wound disruptions may be classified under the following headings: (a) Increased intra-abdominal tension; (b) faulty technic; (c) metabolic disturbances, and (d) allergy.

2. In the five cases reported, infection, allergy and metabolic conditions did not play a rôle of postoperative wound disruption.

3. Increased intra-abdominal pressure did not appear to be a primary factor.

4. In all cases, there was a defect in the healing of the peritoneum. This defect in the peritoneum was probably due to faulty technic as previously described.

5. The type of suture material did not effect the rate of postoperative wound disruption.

6. Close observance of the principles of careful and proper peritoneal closure should lower the incidence of postoperative wound evisceration.

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Usually after a period of months or years the thyroid enlargement of simple colloid goiter disappears with medical treatment, or perchance with no treatment at all. In some cases the enlargement continues throughout adolescence, increasing in size in young womanhood, and finally reaching the bosselated state in midlife.

The brief excerpts in this issue have been taken from "Diseases of the Thyroid Gland. Presenting the Experience of More Than Forty Years" by Arthur E. Hertzler (Paul B. Hoeber, Inc.).

ULTRAVIOLET IRRADIATION OF AUTOTRANSFUSED BLOOD IN THE TREATMENT OF PUERPERAL SEPSIS

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AFTER seven years of clinical research, several physicians in various parts of the United States compiled clinical evidence on a treatment for pyogenic infections that, to date, has not been widely published. These men co-operated and exhibited their findings in the scientific exhibits' section of the American Medical Association Convention held in New York in June, 1940. The exhibit dealt with the treatment of pyogenic infections by the irradiation of autotransfused blood with ultraviolet rays, known as hemo-irradiation therapy.

This paper will deal only with the treatment of puerperal sepsis by that method, giving a description of the procedure and rationale as well as brief comment on other therapeutic measures used and clinical responses noted. The thirteen charts and histories here cited formed a part of the New York exhibit; they represent the total number of cases of puerperal sepsis treated at the Shadyside Hospital, Pittsburgh, Pa. from July, 1937, through May, 1940. Two of these patients were delivered at home and brought into the hospital later. From June 1, 1937, to May 31, 1940, we had 2,486 obstetrical patients delivered. It is significant that since the establishment in July, 1937, of hemo-irradiation therapy, and for the period of time covered by this paper, no deaths have occurred in our institution from puerperal sepsis, one case recovering promptly with sulfanilamide therapy alone.

In April of 1937, we had in our service the second fatal case within a year of beta-hemolytic streptococcus blood stream infection. This case ended fatally, despite intensive therapy with prontisil and prontylin both early and late in the course of the disease. This experience aroused our interest in an article published in the 1934 June issue of *North West Medicine*, by Virgil K. Hancock, M.D., and E. K. Knott, entitled "Irradiated Blood Transfusions in the Treatment of Infections." Their work on all types of conditions resulted in the belief that in the treatment of pyogenic infections they had, in the irradiation of the blood with ultraviolet spectral energy, a therapy of more pronounced value than any other method known to date.

We started at Shadyside Hospital on cases indicated for treatment by the Knott technic. The results we obtained were gratifying. Our experience with this form of therapy has been wide enough to indicate its usefulness as a valuable adjunct to the treatment of various pathologies.

The procedure is as described by Hancock and Knott, and consists of a treated autotransfusion. Briefly, the patient's own blood is withdrawn from a vein, citrated and returned by gravity to the same vein. As it flows back, the blood passes through a specially designed chamber (capacity 10 cm.) with a quartz window and is exposed to ultraviolet rays which are generated by a water-cooled mercury vapor quartz burner. The average time for 10 cm. to traverse the chamber is nine to ten seconds. The average amount of blood used is 1½ cm. per pound of body weight. The time of exposure, the quantity of blood irradiated and the frequency of treatment are determined by the pathology and the patient's condition.

The general potentialities of ultraviolet rays have long been recognized by scientists in the biochemical fields of research. These

potentialities have been discussed in certain basic texts and monographs; to give only a partial list, Bragg,[1] Clark,[2] Ellis and Wells,[4] Krusen,[5] Laurens,[6] Mayer,[9] Rahn,[11] Schneider, Herman and Sperti[13] and Steel.[14]

The rationale of hemo-irradiation is based on the following accepted facts on the biochemical action of ultraviolet rays. A listing of all the data that contribute to the rationale of this procedure is prohibited by space. It is desirable, however, to list a few of the factors that influenced the application of ultraviolet rays directly to the blood stream: (1) Activation of sterols into vitamin D;[3a] (2) inactivation of toxins and viruses;[3b,8] (3) increased cell permeability;[3c,d] (4) destruction and inactivation of bacteria;[4,15] (5) absorption of ultraviolet by the blood and emanation of secondary radiations;[7] (6) increased oxygen combining power of the blood;[10] (7) presence of measurable amounts of ultraviolet in normal blood, and the deficiency of such in toxic and septic cases, malignancy and the

We have given approximately 3,000 blood irradiations and have not had any detrimental reactions, but have observed clinical manifestations of the foregoing references. In about 4,000 blood counts taken on treated patients there have been no signs of destructive action on either white or red cells. The tendency of blood irradiation seems to be to raise the red cell count and hemoglobin. An increase of 1,200,000 in red count has been observed overnight. If the count is not increased, it is noticeable that it has been maintained, even through severe infections, including hemolytic streptococcus in the blood stream. The white cell count tends to balance; i.e., the high counts decrease and the low counts increase. In most all instances treatment was followed by a sharp reduction in temperature. If septic temperature continued, the charts show a decrease by lysis. The extreme toxic conditions found in many patients were generally relieved after irradiation, and clinical improvement noted. The need for blood transfusions was definitely reduced.

In the cases of puerperal sepsis being presented, the charts and histories show that blood irradiation therapy was not instituted in some instances until other treatment was not accomplishing desired results. In six cases sulfanilamide was administered but was discontinued in favor of hemo-irradiation. Five patients received transfusions of donor blood. Three of the patients receiving sulfanilamide are counted as receiving donor transfusions. Six patients of the thirteen had only hemo-irradiation therapy.

CASE REPORTS

Case 1. No. 76081, Mrs. M., age forty-one, a negro, was admitted on November 21, 1938 and discharged on December 23, 1938. This patient was referred by Dr. J. P. McComb. The diagnosis was puerperal sepsis (acute septic endometritis).

The patient, para 11, was admitted November 21, 1938 for delivery. Temperature, pulse, and respirations were normal. Routine urinalysis was negative. On November 23, red cell count was 3,980,000, hemoglobin 70 per cent, white cells 10,100—90 per cent neutrophiles. Because of secession of labor pains by this time plus the onset of fever to 102.4°F, consultation was held and a Porro cesarean section performed because of a fibromyoma present in the cervical region. The diagnosis from the tissue examination showed acute septic endometritis and metritis. Sulfanilamide was started immediately and continued for four days or until November 28, inclusive, in doses of 100 gr. the first day and 60 gr. for the next three days. Despite this therapy her temperature reached 104.8°F. by November 28. The sulfanilamide therapy was stopped, and blood irradiation therapy instituted.

Her temperature gradually receded until December 4, with marked improvement in her general condition. There was a gradual rise in temperature during the next two days, reaching a peak of 101.4°F. on December 6. At this time another blood irradiation treatment was given. From this point on she made an uneventful convalescence, being discharged from the hospital on December 23, 1938 in apparently good condition.

Case 11. No. 70154, Mrs. Z., age twenty-seven, white, was admitted on November 19,

1937 and discharged on December 18, 1937. She had been referred by Dr. W. G. Thompson. The diagnosis was puerperal sepsis (acute septic endometritis and parametritis).

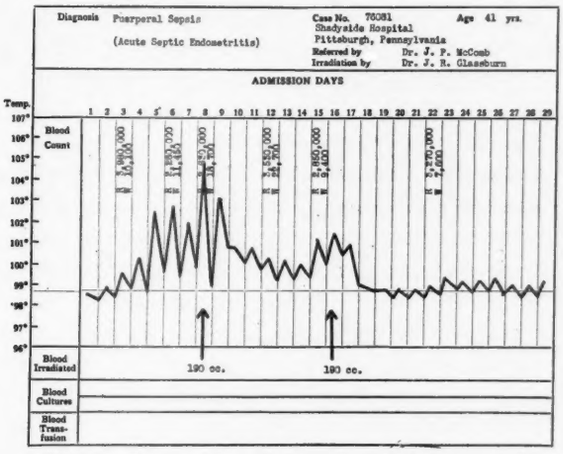

FIG. 1. Case I. No. 76081—Temperature graph.

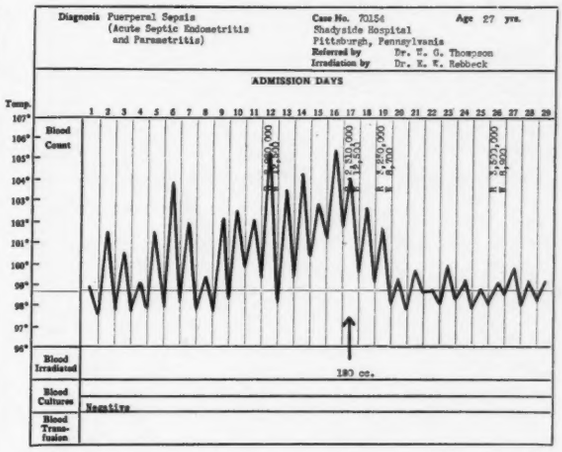

FIG. 2. Case II. No. 70154—Temperature graph.

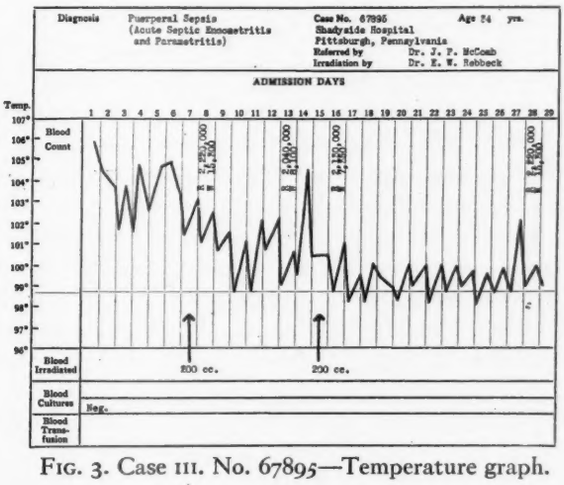

FIG. 3. Case III. No. 67895—Temperature graph.

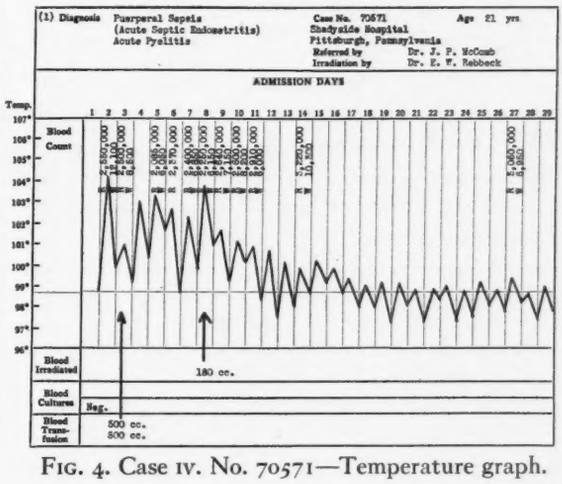

FIG. 4. Case IV. No. 70571—Temperature graph.

The patient, para I, admitted as pre-eclamptic, blood pressure 165/70, albuminuria, with daily injections of magnesium sulfate and 5 per cent glucose and saline (November 19 to November 25). A tube was inserted into the uterus to induce labor on November 20. She was delivered on November 26, of a persistent occiput posterior; November 23 she showed marked pyuria. This increased until November 28; but was negative on the twenty-ninth, thirtieth, and first. Pyuria reports on December 2, 3, 4, 5, 6, 7, 9, 10, 13, 14, 15, 17, and 18. Temperature was 102°F. November 28; on November 29 temperature was 102.2°F. On November 30 the patient complained of pain in the left lower portion of the abdomen; temperature reached 102°F. On December 1 the patient had a chill and the temperature reached 105°F. A soft, tender, non-involuting uterus was present with marked tenderness on pressure over both lower quadrants. The lochia was very offensive. A diagnosis of acute septic endometritis and parametritis was made. Blood cultures taken December 1 and December 5 were negative. This temperature varied from 105 to 101°F. with daily chills until December 6. On the same day blood irradiation therapy was instituted. Her condition was somewhat improved on December 7 and was markedly improved by December 8. This improvement continued uneventfully, and the patient was discharged from the hospital in good condition on December 18, 1937, twelve days after blood irradiation. She was in good health six months later.

CASE III. No. 67895, Mrs. C., age thirty-four, white, was admitted on July 3, 1937 and discharged on July 31, 1937. She had

been referred by Dr. J. P. McComb. The diagnosis was puerperal sepsis (acute septic endometritis and parametritis).

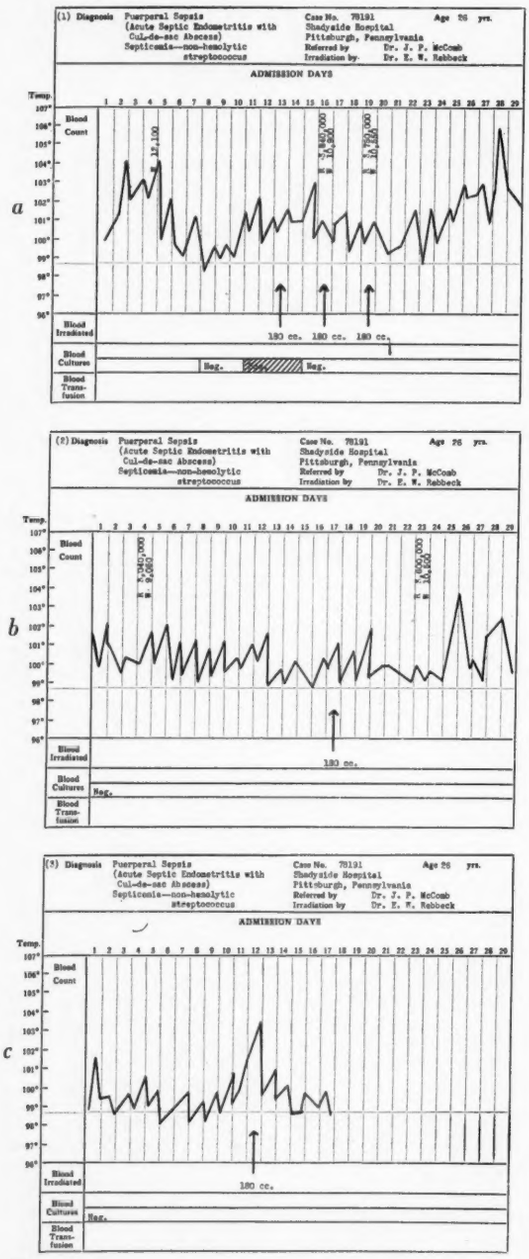
(1) Diagnosis Puerperal Sepsis (Acute Septic Endometritis with Cul-de-sac Abscess) Septicemia—non-hemolytic streptococcus
Case No. 78191 Shadyside Hospital Pittsburgh, Pennsylvania Referred by Dr. J. P. McComb Irradiation by Dr. E. W. Rebbeck
Age 26 yrs.
ADMISSION DAYS
Temp.
Blood Count
a
Blood Irradiated
180 cc. 180 cc. 180 cc.
Blood Cultures
Neg. Neg.
Blood Transfusion
(2) Diagnosis Puerperal Sepsis (Acute Septic Endometritis with Cul-de-sac Abscess) Septicemia—non-hemolytic streptococcus
Case No. 78191 Shadyside Hospital Pittsburgh, Pennsylvania Referred by Dr. J. P. McComb Irradiation by Dr. E. W. Rebbeck
Age 26 yrs.
ADMISSION DAYS
b
180 cc.
Neg.
(3) Diagnosis Puerperal Sepsis (Acute Septic Endometritis with Cul-de-sac Abscess) Septicemia—non-hemolytic streptococcus
Case No. 78191 Shadyside Hospital Pittsburgh, Pennsylvania Referred by Dr. J. P. McComb Irradiation by Dr. E. W. Rebbeck
Age 26 yrs.
ADMISSION DAYS
c
180 cc.
Neg.

FIG. 5. Case v. No. 78191—Temperature graph.

The patient, para VII, admitted on July 3, complained of fever, burning pelvic pain, and gave a history of delivery June 30, (four days previous). Soon after delivery the patient noticed marked pain and tenderness throughout pelvis and lower portion of the abdomen, and in view of the foul smelling lochia with blood clots noted in the physical examination a diagnosis was made of an acute suppurative endometritis and parametritis. On the day of admission Dakinization of the uterus was done. Cervical culture showed staphylococcus. However, the patient continued to run a high septic clinical course with marked toxemia, her temperature ranging between 101.4 and 105°F. for a period of six days. Blood cultures taken July 3 and July 8 proved negative. Routine urinalysis was negative July 6.

On the seventh day of hospitalization blood irradiation therapy was instituted, and at the end of thirty-six hours the patient seemed markedly improved. The next few days her red cell count varied between 2,040,000 and 2,540,000; her hemoglobin between 45 and 75 per cent; and her white cell count between 8,450 and 15,300. Despite her apparent clinical improvement the patient continued to run a temperature varying between 98.4 and 103.4°F. for the next six days, and on the seventh day following irradiation therapy reached 104.6°F. with chills at this time July 16. On July 17, blood irradiation therapy was repeated. The patient improved markedly in twenty-four hours and except for a rise to 102.2°F. on July 29, 1937 convalesced uneventfully and was discharged July 31, 1937.

CASE IV. No. 70571, Mrs. H., age twenty-one, white, was admitted on December 16, 1937 and discharged on January 17, 1938. She had been referred by Dr. J. P. McComb. The diagnosis was puerperal sepsis (acute septic endometritis acute pyelitis).

This patient, para II, was admitted December 16, for cesarean section because of a history of an extremely difficult labor fourteen months previously. Temperature, pulse and respirations were normal on admission. Following cesarean section the day of admission the patient began to have chills and run a septic temperature ranging between 100 and 103.2°F. On December 17 *x*-ray examination of the chest was negative. A persistent pyuria with right-sided kidney distress later accompanied by left-sided kidney distress persisted with chills for the next week; likewise, an aching, tender sensation in the uterus continued present for about a week. Blood counts were as listed above. The lochia never became offensive. The patient became extremely septic. Blood cultures taken December 17 and December 23 were negative. A diagnosis of acute pyelitis, bilateral, and acute septic endometritis was made

by her attending physician and consultants. A transfusion was given of 1,000 cm. of blood on December 18.

On December 24 with a temperature reaching 103.4°F., pulse 120 to 130, respirations 28 to 32, blood irradiation therapy was instituted. There was a slight rise of temperature to 103.8°F. The patient at this time was quite toxic and considered in a desperate condition. Her subsequent course as shown by the temperature graph was steady improvement until she was discharged on January 17, 1938, the thirty-fourth postpartum day, in good condition. She has remained in good health since her discharge.

Case v. No. 78191, Mrs. S., age twenty-six, white, was admitted on April 8, 1939 and discharged on July 2, 1939. She had been referred by Dr. J. P. McComb. The diagnosis was puerperal sepsis (acute septic endometritis with cul-de-sac abscess: septicemia—non-hemolytic streptococcus).

Mrs. S. was aged twenty-six, para 1, had a normal delivery April 9. Within twenty-four hours she developed chills with excursion of temperature to 104°F. degrees, pulse 130, respirations 22. Culture from the cervix at this time showed non-hemolytic streptococcus. A diagnosis of acute septic endometritis was made because of a tender, slow involuting uterus with offensive lochia; likewise, a diagnosis of dementia praecox was made by the neurological department. Blood cultures taken on April 10 and April 12 were negative. The blood cultures taken April 19, April 20, and April 22 were positive for non-hemolytic streptococcus gamma type. She received sulfanilamide therapy, averaging 60 to 120 gr. daily from April 10, to April 20. Blood irradiation treatments were given April 21, April 27, and May 24. Subsequent blood cultures on April 23, April 25, April 26, April 27, April 29, May 1, May 3, May 4, May 9, May 15, May 18 were all negative. On the twenty-eighth postpartum day, abscesses in the right vaginal wall near the introitus and the cul-de-sac were incised. Contaminating organisms only showed on culture. On the thirty-third postpartum day, an abscess appeared over the left scapular region; this was incised and pus, culturing non-hemolytic gamma streptococcus, was obtained. There was a tendency to further excursion of temperature on the forty-fifth postpartum day, and another blood irradiation treatment was given at this time. Her subsequent progress has been uneventful surgically. This case was complicated by dementia praecox of the manic type. She was discharged from the hospital on August 2, 1939 in good condition, having been treated for her mental condition by "shock" therapy upon recovery from the obstetrical complication, June 4, 1939. The patient was last seen in October, 1940, at which time she seemed in good health and, while still under treatment by the neurological department for dementia praecox, was considered as making excellent progress from the latter illness.

Case vi. No. 83568, Mrs. M., age twenty-three, white, was admitted on March 8, 1940 and discharged on March 25, 1940. She had been referred by Dr. J. R. Glassburn. The diagnosis was puerperal sepsis (acute septic endometritis).

The patient, para 1, was admitted in labor March 8, and was delivered a few hours later on the same day. Low forceps were used and an episiotomy was done. The patient left the delivery room in apparently good condition. Her first four postpartum days were uneventful, but on the fifth postpartum day, March 13, 1940 the patient had a large emesis and complained of pain in the lower portion of the abdomen followed by a chill with a rise in temperature to 103.2°F. Her offensive lochia cultured indifferent streptococcus. Blood cultures taken March 14, 15, 16, 17, 18, 19, and 22 were all negative. The following day her temperature rose to 105°F.; general toxic symptoms developed. Blood irradiation therapy was instituted.

The following day the patient's temperature rose to 105.2°F. Forty-two hours after blood irradiation her temperature fell to 100°F.; her blood count taken the previous day proved to be 2,870,000—red blood cells, 10.2 Gm.—hemoglobin. A 500 cm. transfusion was given. The patient throughout this day appeared markedly improved in every respect. On the seventeenth she showed a rise in temperature to 102.8°F. which fell the following morning to 99. From this point on the patient convalesced uneventfully and was discharged March 25 in apparently good health.

Case vii. No. 73574, Mrs. B., age twenty, a negro, was admitted on June 28, 1938 and discharged on July 10, 1938. She had been referred by Dr. P. D. Bier. The diagnosis was puerperal sepsis (acute septic endometritis).

This patient, para iv, was admitted June 28, with normal temperature, pulse and respira-

tions. She was delivered on June 30, with a left occipito-anterior presentation. Routine urinalysis was negative June 28. On July 2, the patient had a large piece of placental tissue removed, followed by a discharge of sanguineous, offensive smelling lochia. The uterus was tender to palpation. A diagnosis of acute septic endometritis was made. Following this her temperature rose to 102.8°F. The following day her temperature rose to 104°F.; this was accompanied by frequent chills and a weak, thready pulse. Blood culture taken at this time, July 3, was positive for Staphylococcus albus, probably contamination. Blood culture taken July 6, was negative. Routine blood count revealed a red count of 2,570,000 hemoglobin 55 per cent, and white cell count 14,200.

The temperature rise and chills persisted on the following day, July 4, and on July 5 blood irradiation therapy was instituted. The day following irradiation, July 6, the patient was generally unimproved with her temperature rising to 103.4°F. Blood culture taken on this day was negative. However, her temperature began to fall on July 7, and the condition improved markedly. She progressed rapidly and uneventfully for the next three days leaving the hospital July 10, 1938 in good condition, five days after her one blood irradiation.

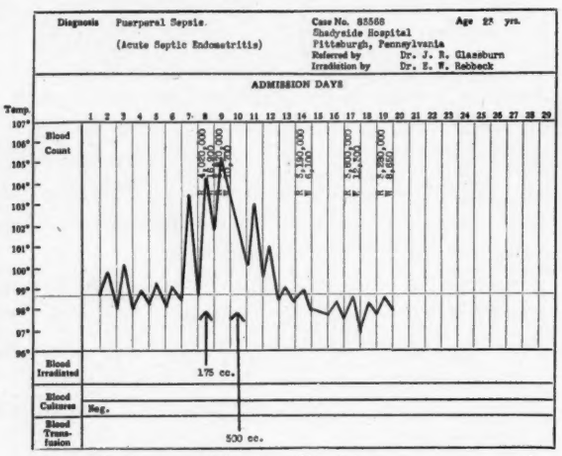

Fig. 6. Case VI. No. 83568—Temperature graph.

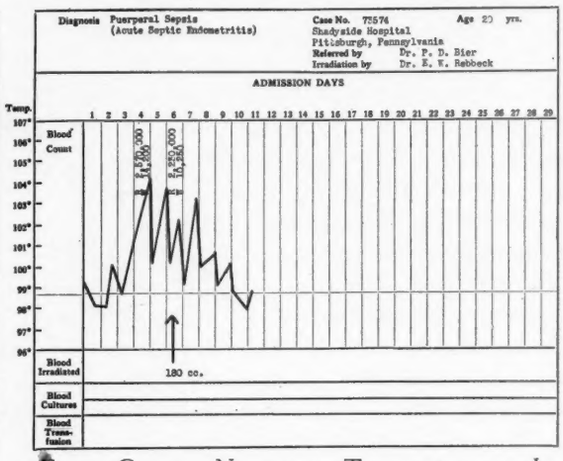

Fig. 7. Case VII. No. 73574—Temperature graph.

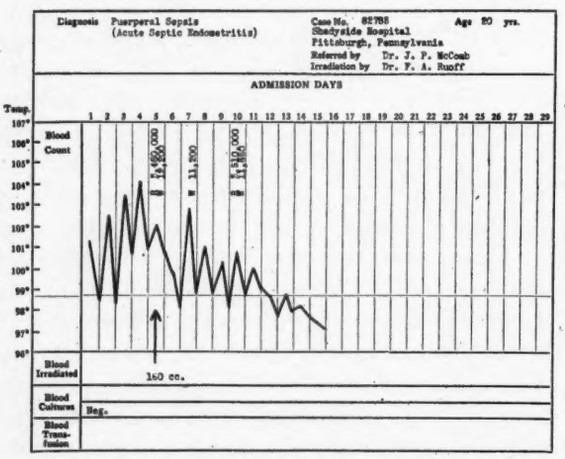

Fig. 8. Case VIII. No. 82783—Temperature graph.

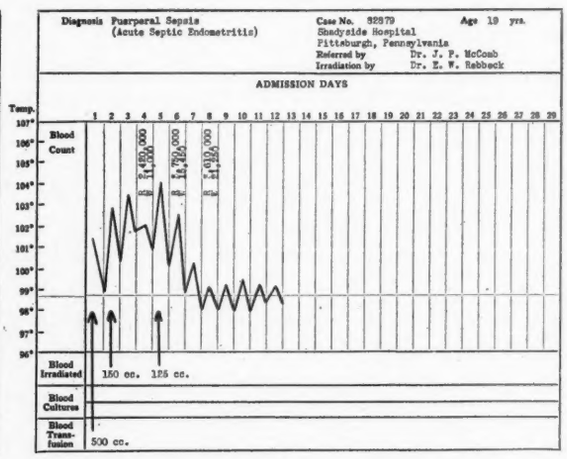

Fig. 9. Case IX. No. 82879—Temperature graph.

Case VIII. No. 82783, Mrs. M., age twenty, white, was admitted on January 21, 1940 and discharged on February 4, 1940. She had been referred by Dr. J. P. McComb. The diagnosis was puerperal sepsis (acute septic endometritis).

The patient, para II, was admitted on January 21, in labor and was delivered the same day. Delivery was normal. During the second stage lacerations occurred which were repaired. Temperature, pulse and respirations were normal on admission. The same day following delivery her temperature rose to 101.4°F. This rose the first postpartum day to

102.4°F.; the next day to 103.4°F., on the third day to 104°F. Cervical, vaginal and blood cultures taken on January 24, showed staphylococcus albus. The uterus was tender to palpation, and a diagnosis of acute septic endometritis was made.

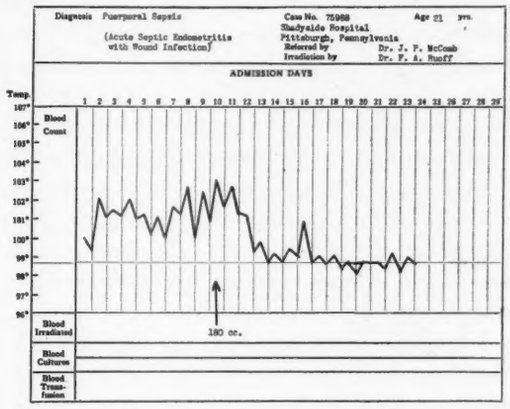

FIG. 10. Case X. No. 75988—Temperature graph.

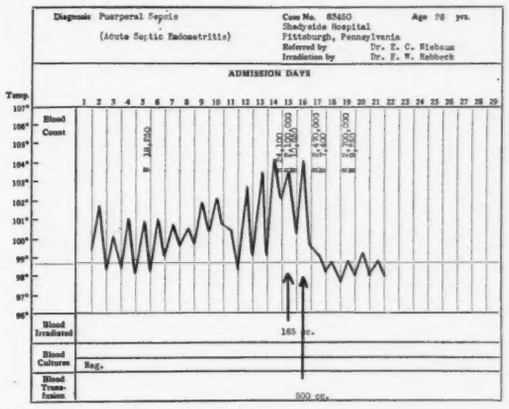

FIG. 11. Case XI. No. 83450—Temperature graph.

On January 25 blood irradiation therapy was instituted. Her temperature fell the following day to 98°F. Marked improvement in the clinical condition was noted, but forty-eight hours after blood irradiation the temperature rose to 102.8°F. Temperature dropped the following day to 98.8°F. and slowly subsided. The patient improved clinically with subsidence in temperature and convalesced uneventfully until the day she was discharged in apparently good health on February 4, 1940.

CASE IX. No. 82879, Mrs. H., age nineteen, white, was admitted on January 27, 1940 and discharged on February 8, 1940. She had been referred by Dr. J. B. McComb and Dr. W. B. Shepard, Jr. The diagnosis was puerperal sepsis (acute septic endometritis).

This patient, para II, was admitted on January 27. Admission temperature was 99.4°F., pulse 110, respirations 22. After a twenty-four hour trial of labor, and, because of moderate cephalopelvic disproportion, a cesarean section was performed. The patient left the operating table in very poor postoperative condition, and a 500 cm. transfusion was given. For her first postoperative day she continued in poor general condition with pulse ranging from 120 to 140. Blood irradiation therapy was instituted at this time. Her temperature dropped to 100°F. that evening but rose again next day to 103°F. Even with this increase in fever her general condition seemed considerably improved. Despite this improvement and because of the fever her doctor administered sulfanilamide 90 gr. each day for the next two days followed by sulfapyridine for three more days. On the fourth postpartum day her temperature reached a peak of 104°F. The patient was apparently not responding to therapy and becoming more septic. Blood irradiation therapy was again done on this day followed by rather prompt subsidence of fever and improvement in her general condition. She continued to convalesce uneventfully and was discharged as recovered on February 8, 1940.

CASE X. No. 75988, Mrs. K., age twenty-one, a negro, was admitted on November 14, 1938 and discharged on December 6, 1938. She had been referred by Dr. J. P. McComb and Dr. P. D. Bier. The diagnosis was puerperal sepsis (acute septic endometritis with wound infection).

The patient, para III, was admitted at term with a history of previous cesarean section done in 1932. Cesarean section was done again with delivery of a normal infant. Starting on the day of delivery, November 15, and lasting until November 23 a temperature ranging between 100 and 103°F. persisted. There was persistent tenderness in the uterine region with more than normal vaginal bleeding but no offensive lochia. On November 23 blood irradiation was done, and thirty-six hours later her temperature fell to 99.4°F. There was no evidence at the time of irradiation that the wound was infected, but two days later, November 25, purulent drainage began. Temperature in the meantime had receded and the patient's general condition was greatly improved. No blood cultures or blood counts were taken. Two specimens of urine showed no gross abnormalities. The patient's progress was uneventful after the

irradiation. She was discharged in good condition on the twenty-second postpartum day.

Case xi. No. 83450, Mrs. B., age twenty-six, white, was admitted on February 29, 1940 and discharged on March 20, 1940. She had been referred by Dr. E. C. Niebaum. The diagnosis was puerperal sepsis (acute septic endometritis).

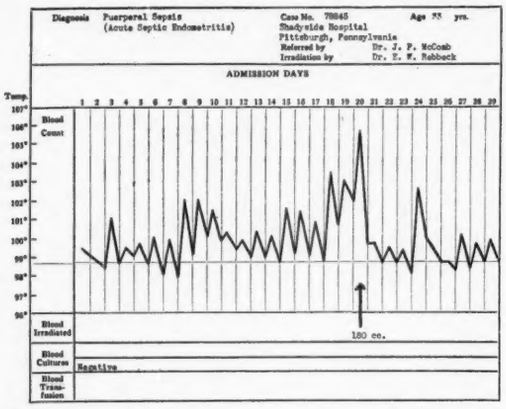

Fig. 12. Case xii. No. 78845—Temperature Graph.

This patient, para 1, was admitted in labor on February 29, and on March 2, was delivered of seven-month old twins; manual removal of the placenta was necessary. Her general condition remained good despite occasional temperature rises from 100 to 102°F. on the first eight postpartum days. Because of fever sulfanilamide averaging from 80 to 120 gr. daily was given from March 8, to March 12, inclusive. However, on March 11 her temperature rose to 102.6°F. following a chill lasting twenty minutes. The uterus was in the pelvis but had been moderately tender for several days. Lochia was serosa but accompanied by many small blood clots, no odor. The breasts were not engorged and there was no kidney tenderness. This temperature continued to rise and on March 12 rose to 103.4°F., on March 13 to 104°F., the white count was 24,000 and the patient became increasingly toxic.

On March 14 when her temperature had not fallen below 102°F. for two days, the patient was given blood irradiation therapy. This was followed by a chill. The temperature dropped to 97.6°F., and rose again the following day to 104°F. The day following blood irradiation, March 15, a blood transfusion of 500 cm. was given. Forty-eight hours after blood irradiation the patient's temperature fell to normal ranges; her toxic symptoms had disappeared. Blood cultures taken March 14, 15, 16, 17, and 18 proved to be negative. She convalesced uneventfully and was discharged March 20, 1940.

Case xii. No. 78845, Mrs. S., age thirty-three, white, was admitted on May 20, 1939 and discharged on June 20, 1939. She had been referred by Dr. J. P. McComb. The diagnosis was puerperal sepsis (acute septic endometritis).

The patient, para 1, was delivered of a full term fetus, left occipito-anterior presentation, on May 22, after approximately forty-eight hours of labor, using mid-forceps. During the first week postpartum she ran a septic temperature which gradually increased to a peak of 102.2°F. by the seventh day. Sulfanilamide therapy was instituted beginning with gr. 40 the first dose, followed by gr. 10, four hourly thereafter for five days. Urine examination on the fifth postpartum day showed a moderate number of red cells, many white cells, otherwise not remarkable. Specimen of urine the seventh postpartum day showed moderate red cells, many white cells. Neither of these specimens was catheterized. Catheterized specimen on the fourteenth postpartum day showed occasional red cells and few white cells. The patient presented no complaints. Involution of uterus and vaginal discharge showed a normal course; breasts presented no pathological condition. On the sixth postpartum day a rather severe diarrhea occurred, persistent for forty-eight hours. On the twelfth and thirteenth postpartum days genitalia were quite tender with some edema. Temperature ranged with peaks gradually coming down to 100°F. until the twelfth postpartum day when without other symptoms the fever began to rise, reaching 103.4°F. on the fifteenth postpartum day, at which time a diagnosis of acute septic endometritis was made. Sulfanilamide therapy was discontinued on the twelfth postpartum day.

Blood irradiation therapy was instituted on the seventeenth postpartum day, from which time with exception of one excursion to 102.6°F. on the twenty-first postpartum day convalescence progressed uneventfully. The patient was discharged on the twenty-ninth postpartum day in good condition.

Case xiii. No. 77357, Mrs. D., age twenty-eight, white, was admitted on February 16, 1939 and discharged on April 23, 1939. She had been referred by Dr. J. P. McComb. The diagnosis was puerperal septis (acute septic endometritis with pneumonic abscesses in cul-de-sac and left pelvic brim; lobar pneumonia).

The patient, para II, was admitted to the Shadyside Hospital on February 16, diagnosis left occipito-anterior presentation at term. She was delivered of both infant and placenta on the same day—a normal delivery. Her admission temperature was 102.8°F., pulse 120, respirations 22. A urinalysis showed occasional white blood cells, no red cells, moderate number epithelial cells, few bacteria; and subsequent examinations included faint traces of albumen, occasional red cells, many white cells, no casts. A septic temperature with peaks of 104.4°F. persisted, and on the fourth postpartum day blood irradiation therapy was instituted. There was a slight improvement in temperature and general condition for the next three days. By the eighth postpartum day temperature again neared the 104°F. mark. Blood irradiation therapy was again instituted. During these days there was considerable abdominal distention with acute dilatation of the stomach, necessitating continuous gastric lavage, and the patient's pulse ranged between 100 and 136. She was moderately toxic. Her blood counts were as shown on the accompanying graphs. Blood cultures taken February 18, February 20, February 24 were all negative. During this time her abdomen was markedly tender, particularly over the entire lower portion.

By the eighth postpartum day diagnosis of pneumonia involving the right lower lobe was made; no sputum, however, was typed. Pitting edema of both ankles developed. Following the irradiation on the eighth postpartum day there was temporary improvement in her general condition with moderate subsidence of fever. She persisted in this edema of the ankes. The pneumonia was apparently gone by the fourteenth postpartum day.

Periodic distention of the abdomen with rather marked tenderness across the lower portion and peaks of temperature to 102.8°F., pulse to 130 persisted until the twenty-second postpartum day when a diagnosis of abscess of the cul-de-sac was made and incision and drainage instituted plus 500 cm. of transfused blood. The patient's toxic symptoms became much more pronounced as well as periodic abdominal distention with marked pain and tenderness in the lower portion of the abdomen. Blood irradiation therapy was again performed on March 16, the twenty-eighth postpartum day, with no appreciable effect as far as improvement. By the thirty-third postpartum day it was decided after consultation that further drainage of the pelvis was necessary. With the

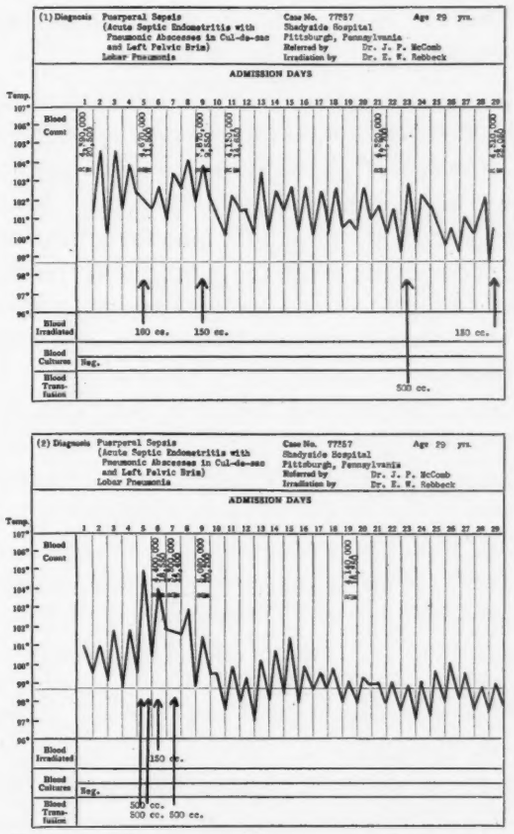

FIG. 13. Case XIII. No. 77357—Temperature graph.

preparation of 500 cm. of transfused blood a pelvic laparotomy was performed; an abscess was encountered with extensive involvement of the left pelvis. This was followed by another transfusion of 500 cm. of blood.

Despite the transfusions the patient continued desperately ill with high fever, and another blood irradiation treatment was given on the thirty-fourth postpartum day, March 22, when the temperature was 104°F., pulse over 160. Forty-five gr. of sulfapyridine were given in two doses prior to irradiation and then stopped. Cultures from both incisions and drainages showed predominance of pneumococci. In the first instance accompanied by bacillus coli and in the second by pseudomonas pyocyanea. Another 500 cm. transfusion was given on the thirty-fifth postpartum day from which the temperature gradually receded, the edema disappeared, the patient became rational, and she was discharged on April 22, 1939

or the sixty-seventh postpartum day, practically afebrile, in fair general condition with the abdominal incision granulating and scant drainage. The patient was last examined in September, 1940, at which time she had apparently made a complete recovery.

In reviewing the charts, we note that one patient developed a blood stream infection of non-hemolytic streptococcus gamma type despite sulfanilamide therapy. However, negative blood cultures were obtained the second day after the first blood irradiation. On several occasions it was necessary to give more than one irradiation before the patient was discharged, but in such instances the patient had a more favorable prognosis after the first treatment. We believe that in the difficult cases treated, many with advanced pathological conditions, that the high percentage of excellent clinical response is unmatched, in our experience, by any other type of therapy.

CONCLUSIONS

Our conclusions in the use of hemo-irradiation are:

1. The exposure of autotransfused blood to ultraviolet spectral energy, as outlined by the Knott technic, is a valuable and safe adjunct to the practice of medicine and surgery.

2. The biochemical background on this type of treatment is extensive and makes its use logical in indicated cases.

3. A definite reduction of toxicity is achieved.

4. In the treatment of puerperal sepsis it has exceptional value.

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THE TREATMENT OF SURGICAL AND TRAUMATIC SHOCK WITH A CITRATED PLASMA-SALINE MIXTURE*

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AN active surgical service is often confronted with a common and serious surgical emergency, secondary shock. It is admitted that no fixed standard can be set for shock; but for clinical purposes we have considered the following signs and symptoms present in whole or part as essential in the diagnosis of shock in the order of their importance: (1) Systolic blood pressure—80 mm. of mercury or less; (2) pulse accelerated but weak; (3) cool and moist skin; (4) pallor or slight cyanosis; (5) rapid and shallow respiration, and (6) thirst—rarely nausea and vomiting.

When two or more of the above clinical signs were present, the cases were treated for shock. However, of the six objective clinical criteria, the presence of a systolic blood pressure of 80 mm. of mercury or below was required as a part of any combination. There were three exceptions to this rule in the series. These cases exhibited all of the manifestations of secondary shock except that the systolic blood pressure ranged between 90 and 115 mm. of mercury. The normal systolic pressure for these three patients ranged from 150 to 220 mm. of mercury.

Moon[1] defines shock as a "circulatory deficiency, not cardiac nor vaso-motor in origin, characterized by a decreased blood volume, decreased cardiac output (volume flow) and by an increased concentration of the blood." Moon also states that the "mechanics for the circulatory deficiencies is the uncompensated disparity between the volume of blood and the volume capacity of the vascular system."

In secondary shock, this disparity is produced by the dilatation of the capillary bed with a resulting hemoconcentration, as evidenced by blood count and hematocrit determinations. As the pathological physiology progresses, there is a greater anoxia of the capillary cells which is followed by an increase in the permeability of the endothelium, thus allowing the plasma to diffuse into the extravascular spaces in large quantities, increasing the disparity between the volume capacity of the vascular system and the volume of circulating blood. The following chart from Moon's text on "Shock" is self-explanatory, and complete in its description of the vicious cycle of the pathological physiology of secondary shock.[1] (Fig. A.)

Based on this theory and work of Moon, the use of plasma seems to be the ideal agent to combat the disparity in the circulation system in secondary shock, as this is the agent lost; the colloids in the plasma exert the osmotic pressure necessary to hold the fluid within the vascular system.

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Plasma and serum have been used by others: Mahoney,[2] in August, 1938, found that regenerated lyophilized plasma was superior to whole blood, saline, or acacia in the treatment of experimental shock produced in dogs by cooling the peritoneal cavity, inducing an excessive loss of plasma.

In 1936, J. A. Elliott[3] described a vacuum system of drawing blood and preserving plasma. He suggested the use of plasma in the treatment of shock, but no mention of the actual clinical use was made. Bone and Wright[4] related the following conclusions on the use of lyophilized serum intravenously in shock produced in dogs by trauma to the gut or an extremity: "The blood pressure was raised and maintained for several hours by this procedure." They further stated, "The immediate availability of lyophilized serum—its theoretic stability and its action upon shocked animals suggests its use as a valuable treatment for clinical shock and hemorrhage."

Fantus[5] writes, "Serum would be more valuable than 6 per cent acacia solution in shock where there is little or no hemorrhage, and that blood serum would be a more rational treatment for shock produced by extensive burns, and that serum may furnish the principle of certain hemorrhagic conditions." No mention of the actual use of serum was made in this article.

Lehman[6] described a simple syphoning method of preparing plasma in 1939. Hughes[7] and his group found a reduction of

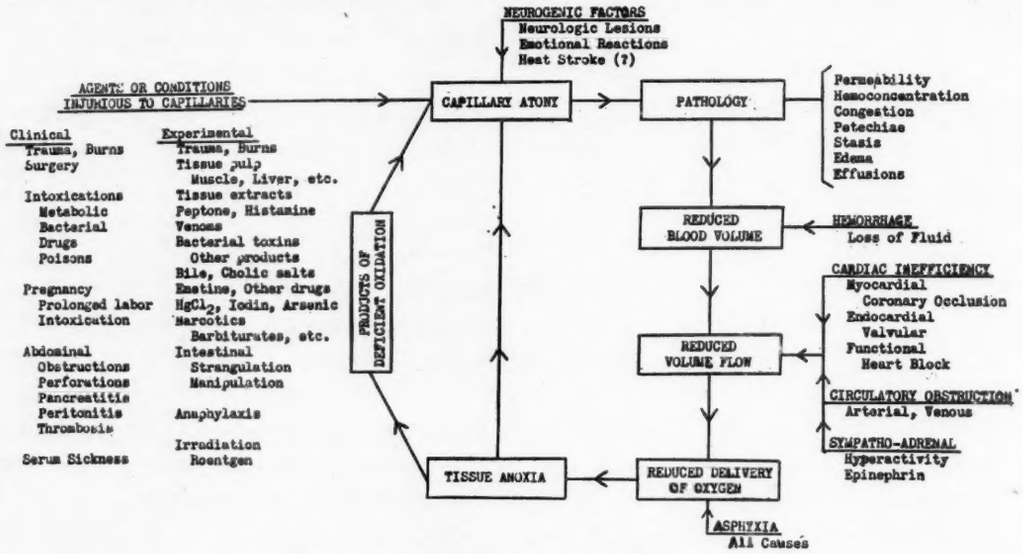

FIG. A. The vicious cycle. (After Moon.)

increased intracranial pressure by the intravenous use of concentrated solution of human lyophilized serum. Levinson[8] and his associates presented an excellent study on the effectiveness of serum in the treatment of hemorrhage and shock in dogs.

McClure[9] in his discussion of the treatment of burns advises that "when the hemoglobin values are more than 15.6 gms., plasma transfusions should be given." Darrow[10] makes the following statement for the use of plasma in his article on the treatment of dehydration, acidosis, and alkalosis: "The maintenance of blood volume and circulation is essentially the treatment of shock—namely, blood or plasma transfusions, intravenous infusion of dextrose and at times of salt solutions."

Tatum, Elliott, and Messett[11] in December, 1939, described in detail a method of preparing plasma and the use of untyped or incompatible plasma in 191 cases without reactions.

Brodine and Saint Girons[12] "stressed the advantage of using plasma in place of whole blood in severe hemorrhages." They believe that the danger of hemorrhage lies in the loss of the volume of blood and much less in the loss of erythrocytes. "If the volume

of blood is reduced to one-fourth, death is inevitable." Recently, Strumia[13] and his group in a very complete report showed that "citrated blood plasma was the ideal means of restoring an adequate blood circulation in patients suffering from secondary shock, thus rapidly relieving the clinical manifestations of shock." Strumia[14] also writes that "serum gives reactions but citrated plasma does not."

Serum, citrated plasma, and regenerated lyophilized serum or plasma all seem to be clinically effective.

In view of the above overwhelming evidence of the value of plasma in the treatment of surgical shock, it was decided to make this therapeutic agent available in our hospital to meet his operative complication. During the past year we have utilized blood plasma as a by-product of the blood bank in eighty-one cases of secondary shock, using the above criteria as a basis for administration. The types of cases reported fall into two large groups.

Surgical Shock. The first type were those in which shock occurred during or after a surgical procedure. There were sixty-three cases in this group. Shock developed as late as forty-eight hours after the surgical procedure.

Traumatic Shock. The second type were those in which shock followed traumatic conditions outside the hospital, but excluding those in which there was gross hemorrhage. There were eighteen cases in this group. The plasma used in the treatment of these patients was prepared by two methods: The first by syphoning off the supernatant plasma from stored blood seven to ten days old and mixing with equal parts of saline. This was an open method and the plasma obtained by this method was used within twenty-four hours of preparation and stored at 4°C. The other plasma used in transfusions was drawn into vacuum bottles, stored at 4°C. for two to ten days, centrifuged for one hour at 2,000 revolutions per minute; and the supernatant plasma obtained from this outdated citrated blood was drawn into another sealed vacuum bottle containing 250 cc. saline, the entire procedure being carried out under aseptic and closed system. The plasma prepared by this method was kept at room temperature (without preservatives in vacuum flasks containing 500 cc. of this equal mixture of plasma and saline, which had been previously serologically tested) for periods varying from one day to eight months after preparation.

In 500 injections we have had only two reactions. The first one occurred after the injection of 75 cc. of plasma. The patient complained of chilliness and a faint feeling. The infusion was discontinued immediately. Following this the patient developed a temperature of 104°F., but no further complications occurred. Culture of the plasma gave a Staphylococcus albus. The second reaction occurred in a patient with a severe pelvic peritonitis and hypoproteinemia. One half hour after the completion of the intravenous injection of 1,000 cc. plasma-saline, the patient developed a chill lasting twenty minutes, and this was followed by a temperature of 104°F. The patient had been showing septic temperature previous to the injection with daily variations between 100 and 103°F. No further complications developed and the patient was again transfused with a plasma-saline in a few days without any complications. The plasma used in each of these cases was prepared by the open (first) method.

The five following case abstracts and charts are presented as illustrative of the results obtained in group one, *occurring during or after surgical procedure:*

CASE REPORTS

Case 1. A colored male, aged fifty years, had osteomyelitis of the skull plate following a previous operation for a cerebellar tumor. Before the operation blood pressure was 160/110 and pulse 100. An ether ethylene anesthesia was administered. One hour after the operation began, blood pressure was 120/84 and pulse 120. During the next hour there was a

gradual drop of blood pressure and a rise of the pulse, so that one and one-half hours after the beginning of the operation, blood pressure was

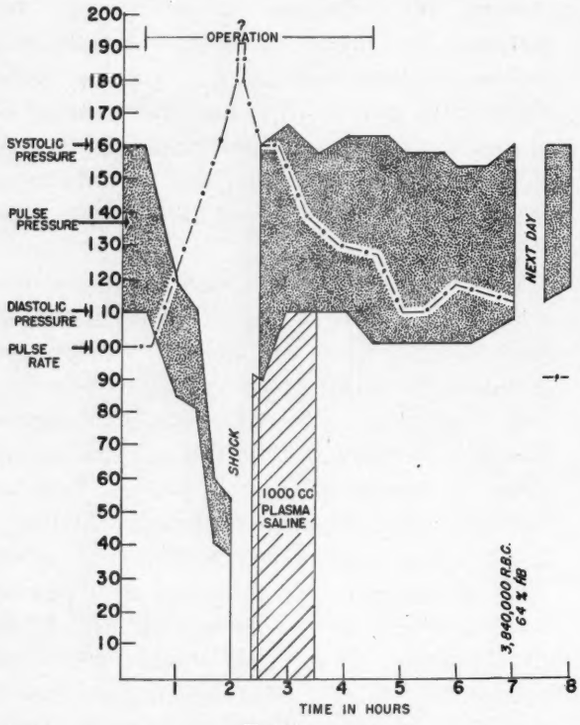

Fig. 1.

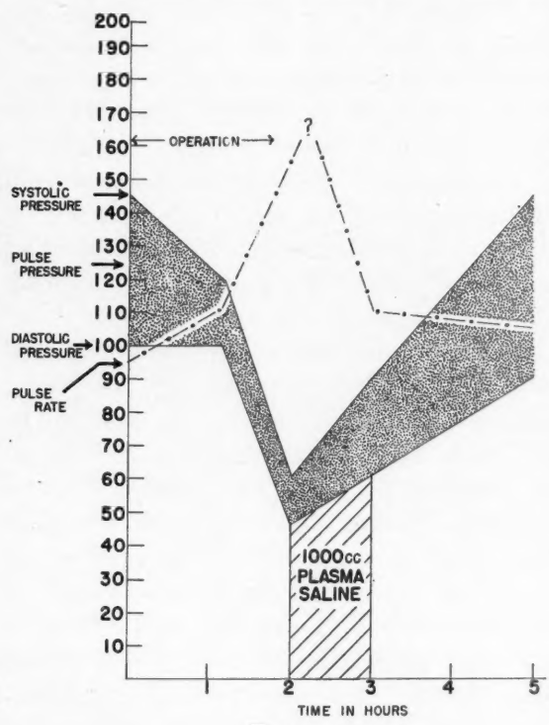

Fig. 2.

Fig. 1. Case I. Surgical shock. Removal of osteomyelitic skull plate.
Fig. 2. Case II. Surgical shock. Fibroid uterus; supravaginal hysterectomy and salpingo-oophorectomy.

60/40 and pulse 160. The other clinical signs of shock were now present. Fifteen minutes later, 1,000 cc. of a plasma-saline mixture was started intravenously. At this time blood pressure was 50/30 and the pulse too rapid to count. After receiving 250 cc. of the mixture, blood pressure was 160/90 and pulse 166. The remainder of the plasma was given during the next hour. Blood pressure was 155/110 and the pulse 140 at the completion of the intravenous injection. No clinical signs of shock were present. The operation, removal of the osteomyelite skull plate, took four hours, the pressure at this point being 160/100 and the pulse 126. During the next few hours the pulse gradually dropped to 110, the blood pressure remaining at 160/110. No evidence of latent or delayed shock occurred that day or the first postoperative day. (Fig. 1.)

Case II. A colored female, aged fifty-three, was admitted with a fibroid uterus. A supravaginal hysterectomy and bilateral salpingo-oophorectomy, which required one hour, was performed. Blood pressure and pulse before the operation were 144/100 and 94, respectively. At the end of the operation blood pressure was 120/100 and pulse rate 110. The patient showed none of the clinical signs of shock. One hour after the operation was completed, the patient was in surgical shock with a blood pressure of 60/45 and a pulse rate too rapid to count. One thousand cc. of a plasma-saline mixture was given intravenously with a gradual rise in the next hour of blood pressure to 90/60 and a fall of pulse rate to 116. The skin was dry but still cool. No other medication was given after this. There was a gradual rise in blood pressure with a drop in pulse rate in the two hours following completion of the intravenous administration to the normal level of 144/90 and 108. From then on the patient made an uneventful recovery. (Fig 2.)

Case III. A white female, aged thirty-eight, with unilateral pulmonary tuberculosis was operated upon for a third-stage thorocoplasty. Before the operation, blood pressure was 110/70 and pulse 86. During the operation, blood pressure dropped to 90/70 and pulse rate rose to 110. There were no other signs of clinical shock. Soon after the patient was returned to her room, her blood pressure dropped to 70/55 and pulse was 120 but very weak. The skin was cold and clammy. Before the plasma (500 cc.) was started the pulse had risen to 144. Within

ten minutes after the plasma was allowed to flow intravenously, pressure was 90/70 and pulse rate 140. Twenty minutes later the pressure was the same but the pulse had fallen to 120. Forty-five minutes were required for the intravenous injection of the 500 cc. of plasma-saline mixture. Pressure was 100/70 and pulse 100 at this point. The patient made an uneventful recovery. (Fig. 3.)

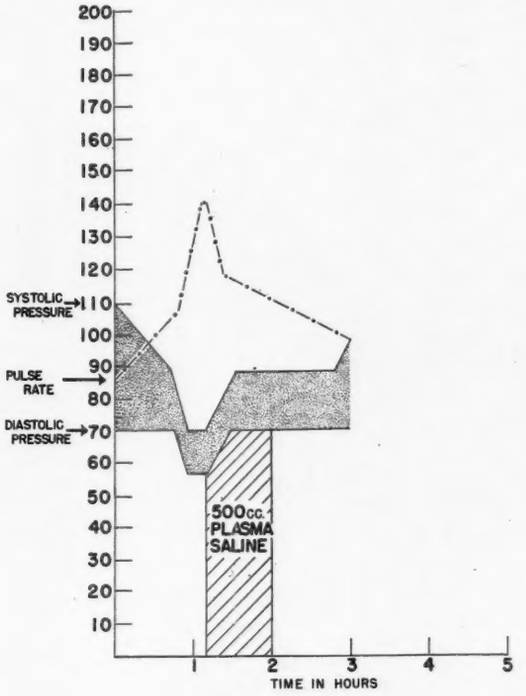

Fig. 3.

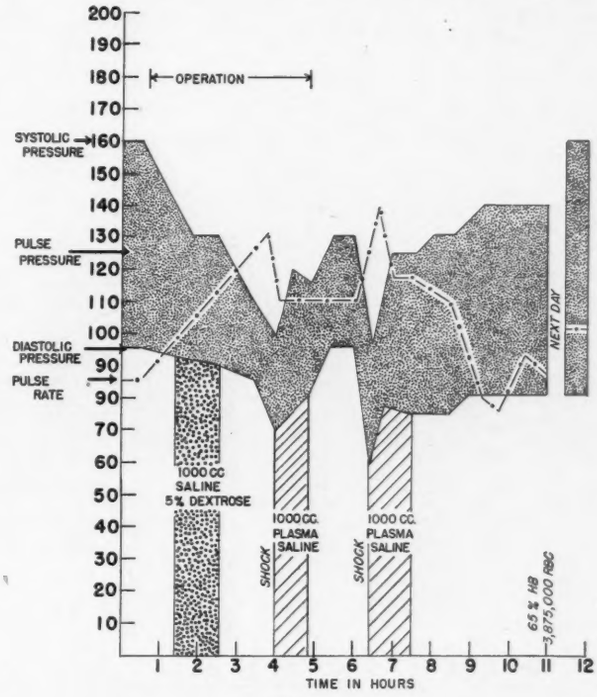

Fig. 4.

Fig. 3. Case III. Surgical shock. Thorocoplasty; pulmonary tuberculosis.
Fig. 4. Case IV. Surgical shock. Craniotomy; removal of pituitary tumor.

Case IV. A colored female, aged forty-two, was operated upon for a pituitary tumor. Blood pressure was 160/96 and pulse 84 before the operation. One and one-half hours after the operation began, blood pressure was 144/96 and pulse 100. The skin was cool and the patient was perspiring freely. One thousand cc. of 5 per cent dextrose in saline was given intravenously. After the infusion the blood pressure continued to drop. This clearly illustrated the ineffectiveness of crystalloid solutions in shock. One and one-half hours after the saline was given, blood pressure was 90/64 and pulse 130. The patient now exhibited all of the classical clinical signs of shock. In view of this, 1,000 cc. of plasma-saline mixture was administered. One half hour after the infusion was started, blood pressure was 120/70 and pulse 110. Operation was completed at this point. There was a gradual rise in blood pressure and decrease in pulse rate during the next hour. Pressure was now 130/90 and pulse 108. Thirty minutes later the patient was again in shock with a blood pressure of 84/60 and a pulse of 140. This demonstrated the necessity of close observation for the development of secondary shock. Plasma was not a complete protection. One thousand cc. of plasma was started immediately at this low level and there was an immediate response with the blood pressure returning to 120/74 and pulse 108. During the day there was a gradual rise of blood pressure to 140/80 and a fall of pulse to 80. The course was stormy. Coma developed and the patient died on the fifteenth postoperative day of cerebellar hemorrhage. (Fig. 4)

Case V. A colored female, aged thirty-six, was admitted with a large uterine myoma. Blood pressure and pulse before the operation were 110/60 and 86, respectively. At the operation, a right tubo-ovarian mass was found markedly adherent to an atrophied ectopic kidney. This was removed. During the latter part of the operation, which required an hour, the patient exhibited a blood pressure of 90/50 and a pulse of 120. One thousand cc. of 5 per cent dextrose in saline was given and the

patient responded for half an hour with a rise in blood pressure to 100/50 but no change in the pulse rate. One and one-half hours after the

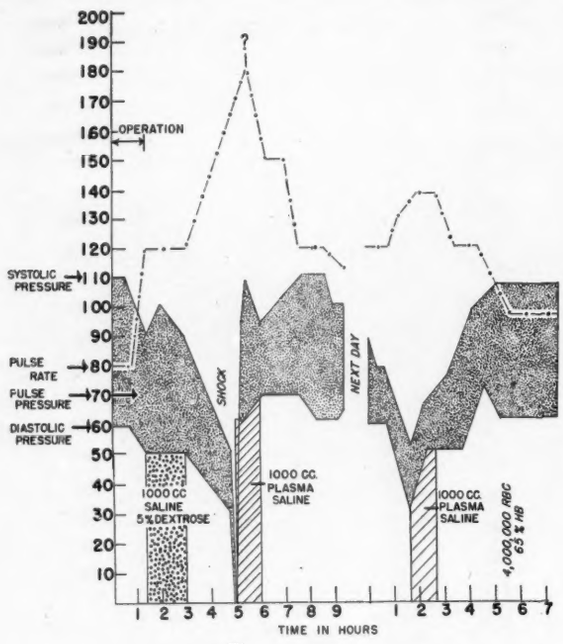

Fig. 5.

Blood pressure was 110/70 and pulse 120. However, fifteen minutes later blood pressure was 80/55 and pulse 160. The patient mani-

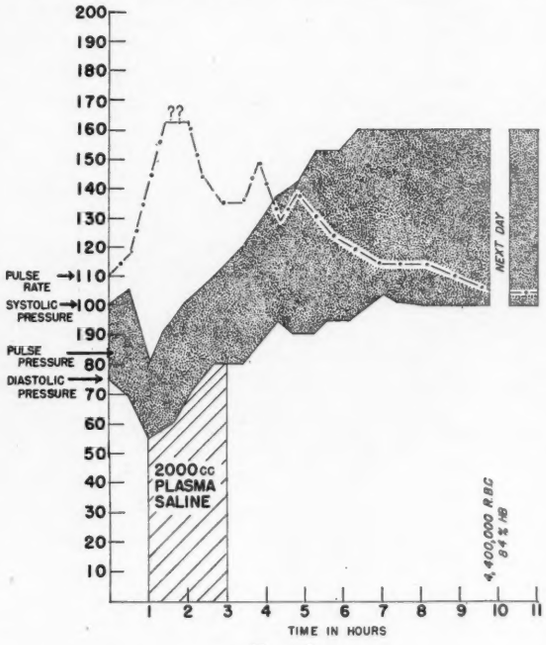

Fig. 6.

Fig. 5. Case v. Surgical shock. Hysterectomy; removal of ectopic kidney.
Fig. 6. Case vi. Traumatic shock. Fractured femur, three ribs, bruises.

crystalloid infusion, the patient was in severe shock with all the classical signs and a blood pressure of 50/30. A few minutes later the blood pressure could not be obtained and the pulse was too rapid to count. One thousand cc. of a plasma-saline mixture was given. After receiving 300 cc. of the plasma the blood pressure rose to normal level in half an hour and the pulse dropped to 160. The course throughout the remainder of the day was satisfactory with a maintenance of a normal blood pressure and a gradual decline of the pulse rate to 120. The next morning blood pressure was 90/60 and pulse 130. The skin was a little cool and moist. During the next hour, the blood pressure fell to 50/20 and the pulse rose to 150. The patient was in secondary shock and 1,000 cc. of plasma-saline mixture was given. The blood pressure and pulse gradually returned to normal level. She made an uneventful recovery. (Fig. 5.)

The following two cases are typical of *traumatic shock without hemorrhage:*

Case vi. A white male, aged fifty-six, was admitted after an automobile accident with a fractured femur, three fractured ribs and numerous bruises. The skin was dry and warm.

fested all of the classical signs of shock. Plasma-saline mixture was given immediately. One-half hour after the intravenous injection was started, blood pressure was 90/70 and pulse 160. One hour after the intravenous injection was begun, pressure was 100/70 and pulse 160. The patient's skin was still cold and clammy. Two thousand cc. of plasma-saline mixture was given. At the completion of the infusion, which required two hours for administration, blood pressure was 110/74 and pulse 130. Clinically, the patient was much improved at this point. Within the next two hours pressure gradually rose to 150/90 and pulse dropped to 120. The next hour showed a blood pressure of 160/90 and a pulse rate of 110. From this time on there was no change in blood pressure but a gradual decline of pulse to 100. His recovery was without incident but he was hospitalized a long period for treatment of the fracture of the femur. (Fig. 6.)

Case vii. A young, colored male was admitted after an automobile accident which resulted in a fractured tibia, fibula, three ribs and a right Colles' fracture. At the time of admission the patient was in severe shock. No blood pressure was obtainable and the pulse

rate too weak and rapid to count. The skin was cold, pale, clammy and slightly cyanotic. Plasma-saline mixture was started immediately. After receiving 400 cc. the pressure had risen to 60/15 but the pulse was still very weak and rapid. Two thousand cc. of the plasma-saline mixture was given within the first two hours after admission. At this time there was a gradual rise in blood pressure to 90/50 and a fall of pulse to 120. At the end of the intravenous injection the patient's condition was much improved. There was steady improvement. The blood pressure returned to normal and pulse rate dropped to 110 two and one-half hours after admission. (Fig. 7.)

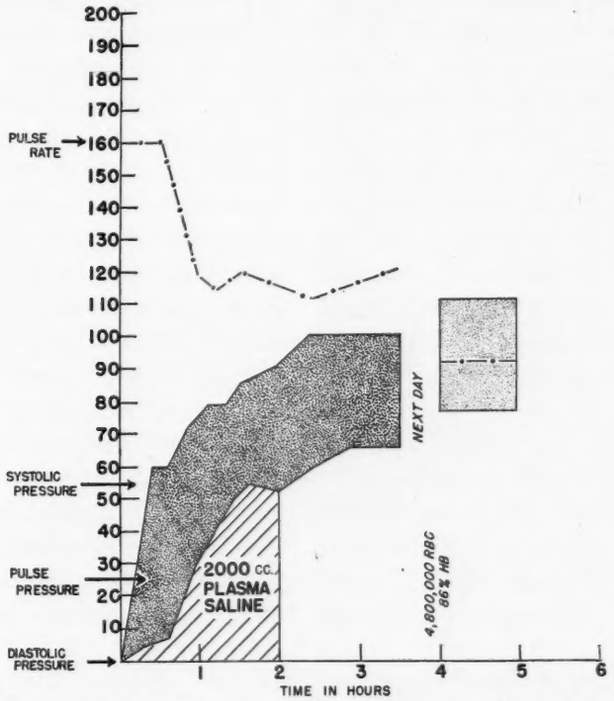

Fig. 7. Case vii. Traumatic shock. Fractured tibia, fibula, three ribs and right Colles' fracture.

DISCUSSION

Surgical Shock. Case 1 is an example of the common occurrence of shock during an operative procedure. One-third of the sixty-three cases of surgical shock in our series were similar to the above. Case 1 demonstrated the active response of surgical shock to plasma. After receiving only 250 cc. of the plasma-saline mixture, this patient's blood pressure had risen to 160/90 from 50/32. All of the twenty-one patients in this class responded immediately and made complete recoveries from shock with plasma infusions. (It is the added support which plasma gives this group which will, no doubt, allow more surgery to be performed at each operation.)

Cases 11 and 111 are prototypes of the frequent shock states occurring immediately or soon after surgical procedures. Both patients showed immediate and sustained response to plasma. The difference in doses between Cases 11 and 111 was determined by the size of the patient, clinical appearance of the patient, and the length of the operation.

The question might be raised at this point if cases of this type would not respond as well to infusion of glucose in saline. It is difficult to answer this question completely. We believe that many cases of surgical shock might respond well to crystalloid solutions if they are only in early and mild shock states. However, if the pathology has passed beyond this point and there already exists some increase in the capillary permeability, crystalloids will not suffice; and a

colloid preparation of plasma is required for permanent and efficient results. Previous to the use of plasma in our institution, most of the thorocoplastic patients received a blood transfusion immediately after operation. This is probably the custom among other thoracic surgeons. However, we now use plasma practically exclusively, since most thorocoplastic operations are not accomplished by excessive blood loss and our results have been all that could be desired. If a tuberculous patient is anemic, we treat anemia with repeated small blood transfusions pre- and postoperatively.

Cases IV and V represent shock treated with crystalloids without or with only minor reponse and also instances in which the shock states were severe enough not to respond completely and permanently to one plasma infusion. These examples serve to remove the impression which may prevail that one infusion of plasma is sufficient for secondary shock.

These cases also illustrate the importance of close observation postoperatively for delayed secondary shock which may develop in spite of what at first seemed to be adequate treatment. In Case IV, the delayed shock occurred one-half hour after a normal level had been reached. Case V did not go into delayed secondary shock until the day after the operation.

Traumatic Shock. Cases VI and VII exemplify the group of shock cases which occur as a result of traumatic conditions outside the hospital. This group is very common in this day and age as a result of traffic accidents. Case VI on admission was in a state of compensation and did not show the clinical signs of shock. However, we are sure that if a peripheral blood count had been done it would have shown hemoconcentration.

Blood pressure alone cannot be the pathognomonic sign of shock. Case VII was in severe shock on admission and treatment was started immediately in the accident room. He required 2,000 cc. of the plasma mixture to overcome his state of shock. Our experience has taught us that secondary shock states (as a result of trauma outside the hospital) usually require more plasma than those which occur during or after the average operative procedure.

Case VII is the classical example illustrating the advantage of having a reserve supply of plasma. If this young man had come into a hospital without a blood bank or plasma bank, he probably would not have survived as the delay necessitated in obtaining donors and blood, probably would have been fatal. Even with a blood bank and without plasma, the minimum of a half hour is usually required to obtain blood for typing and cross-matching. Time consumed in administration of intravenous fluids may determine the outcome of the case. Cases VI and VII are similar to the shock states that occur in warfare and it is this group that would benefit the most by an immediately available unlimited supply of blood plasma.

COMMENT

Our results in eighty-one cases of secondary shock have been satisfactory in most cases and in some even spectacular. We believe that the use of plasma will be routine in surgical services in the treatment of shock. Plasma is particularly an important adjunct to the small hospital. A blood bank as a rule has not been feasible in a small institution where the number of transfusions is less than two a day. A previous report from our blood bank showed that to maintain an adequate supply of blood of all types, at least three transfusions per day were required and a supply of fifteen pints of blood.

Naturally, this is not practical in the small hospital; but with plasma, all of the out-dated blood can be readily converted into plasma and stored for long periods, thus eliminating any waste and assuring the presence of an effective fluid for all emergencies. This will lead to a "Blood-and-Plasma Bank" in place of the "Blood Bank." Likewise, with modern equipment, the simplicity of preparation and handling

of plasma offers an unlimited demand and use. The ordinary transfusion without a blood bank requires the typing of the patient, typing or serological tests upon the donor, venesection and cross-matching before transfusion. Conservatively speaking, this requires at least one to two hours to perform. With a blood bank system, a transfusion requires only typing of the patient and cross-matching of the donated blood. This procedure takes at least one-half hour to be carried out carefully and accurately. Plasma eliminates all of this since it requires no typing, and serological tests have been performed before the plasma is available for use.

Another important advantage of plasma is the absence of reactions as compared to preserved whole blood. Personal records of 2,000 whole-blood transfusions revealed a 6.3 per cent reaction rate of which 0.4 per cent were severe. Plasma eliminates the emergency from emergency transfusions. We believe that in surgical shock, plasma is equally as efficacious if not superior to citrated preserved blood.[15]

The simplicity and ease of storage is another important advantage. Plasma may be stored at room temperature or refrigerated at 4°c. This advantage will probably give the use of plasma a place in military service.

Previous to the use of plasma in our institution, approximately 5 per cent of the banked blood was discarded because it was too old and partly hemolyzed. Plasma has completely saved us this loss, and obviated the necessity of holding blood to the end of a maximum safe-storage period.

The dose of plasma required in different cases depends entirely upon the etiological factors, the duration and severity of the shock. The best way to answer this is to say that the dose is as much plasma as is required to obtain results. We have obtained results in some cases with only 250 cc. of plasma and in others as much as 2,000 cc. was required for a response. Four thousand (4,000) cc. of incompatible or untyped plasma has been given by us to one individual in a continuous intravenous drip.

With the advent of the use of plasma in our institution, we have replaced whole blood transfusions with plasma transfusions in many cases of shock and it has proved clinically most satisfactory.

During the earlier stages of our work with plasma, we often confronted men on our staff who hesitated to use plasma; but now the pendulum has probably swung too far, and plasma is being used very freely here. Time and further study will, no doubt, bring the pendulum back to a more normal arc.

SUMMARY AND CONCLUSIONS

1. Eighty-one cases of surgical and traumatic shock (secondary shock) were treated with a 1-to-1 plasma normal saline mixture that was prepared by centrifugation from out-dated preserved citrated blood. The results were satisfactory in most cases and in some even spectacular.

2. No typing, cross-matching, pooling or heating of plasma was performed before intravenous administration.

3. Plasma may stand at room temperature or refrigerated at 4°c. It has been stored for long periods at room temperature in vacuum containers for eight months.

4. Only two reactions occurred in over 500 intravenous administrations.

5. Large and repeated doses can be given without any obvious complications.

6. The use of plasma eliminated the time consumed in transfusions of whole blood, for it is always ready for immediate use.

7. The more frequent use of plasma will materially aid any active service in the preparation and care of surgical patients.

8. It will probably prevent many cases of delayed surgical shock.

9. The small hospital can conveniently maintain a "Blood-and-Plasma Bank."

10. Plasma offers to the medical services of the armed forces a substitute for whole blood that can be handled with ease under many varied conditions.

11. The loss of out-dated blood that occurs in a blood bank is removed with the use of plasma.

We wish to thank Dr. J. Ross Veal and Dr. J. A. Parks for their co-operation, advice and use of their surgical cases, and Dr. Edgar A. Bocock, Dr. P. S. Rossiter, and Dr. C. C. West for many facilities.

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A NEW OPERATIVE PROCEDURE FOR DUPUYTREN'S CONTRACTURE*

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CONTRACTED fascia is the underlying cause of Dupuytren's contracture. Usually the palmar fascia and its deep extensions to the interosseous fascia are involved.

The principal reason for failing to obtain a permanent cure of the deformity has been the lack of a systematic method for removing all of this contracted fascia. The procedure to be described should lower the high incidence of recurrences after operations for this condition.

The standard textbooks of anatomy give adequate descriptions of the palmar fascia. Some describe the deep extensions to the interosseous fascia. These deep extensions, it will be recalled, help to form canals for the lumbrical muscles, the digital vessels and nerves and the long flexor tendons. It is surprising to find that the text books on surgery as well as the special articles on Dupuytren's contracture invariably lack a detailed method for the complete removal of all of the fascia which may be contracted in this condition.

Regardless of the type of skin incision used it is the general concensus of opinion that the contracted palmar fascia must be removed. Contracture of the deep extensions may contribute to the flexion deformity as much as contracture of the palmar fascia. Removal of these deep extensions in addition to the removal of the palmar fascia is, therefore, essential for a permanent cure of the condition.

The surgeon who is cognizant with the importance of thoroughly removing all the contracted fascia may be restrained from completing a thorough dissection by the fear of injury to the digital vessels and nerves. He usually proceeds to strip the palmar fascia away by sharp dissection, and with his attention fixed on protecting the vessels and nerves may leave strands of this fascia behind. If he appreciates the importance of removing the deep extensions, this may be accomplished in an incomplete and unsatisfactory manner, with the result that the operation may fail to correct the deformity or the deformity is only partially corrected.

After careful dissection of the skin and part of the subcutaneous tissue from the palmar fascia, the method devised by me consists of immediately locating the course of the digital blood vessels under the palmar fascia by palpation. No tourniquet is used and the pulsations of the arteries are easily felt. The vessels with the digital nerves run in canals between the tendon sheaths of the long flexors of the fingers. The course of the tendons in their sheaths under the palmar fascia are in turn easily identified by extending the fingers. No attempt is made to strip off the palmar fascia, but instead this fascia is removed with its deep extensions to the interosseous fascia in the following manner:

A series of longitudinal incisions are made directly over the tendon sheaths and over the canals for the blood vessels and nerves. (Fig. 1.) To prevent injury to the tendons, blood vessels and nerves, a grooved director with a rounded but rather small pointed end is inserted immediately under the palmar fascia, in a proximal direction, and each incision is made through the palmar fascia down to this grooved director. In this manner the canals for the tendons, and for the blood

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vessels and nerves, are opened without injury to the underlying structures.

Two adjacent cut edges of the palmar fascia are secured in a hemostat just distal to the transverse metacarpal ligaments. (Fig. 2.) Traction is made proximally and upward, and at the same time the deep extension or partition from the underside of the palmar fascia is put on the stretch. This deep extension (and immediate adjacent portion of palmar fascia) is removed by incising deep down along the line of its reflection to the interosseous fascia. (Fig. 3.) In this procedure the vessels, nerves and tendons on either side of the partition are protected by retraction. This deep extension or partition will usually be found to terminate proximally along a convex line, which corresponds to the location where the tendons diverge from the common palmar bursa. The individual partition when removed (Insert Fig. 2) will have an irregular shape; its upper margin will be continuous with a flange of palmar fascia extending between two adjacent longitudinal incisions first made; its lower margin

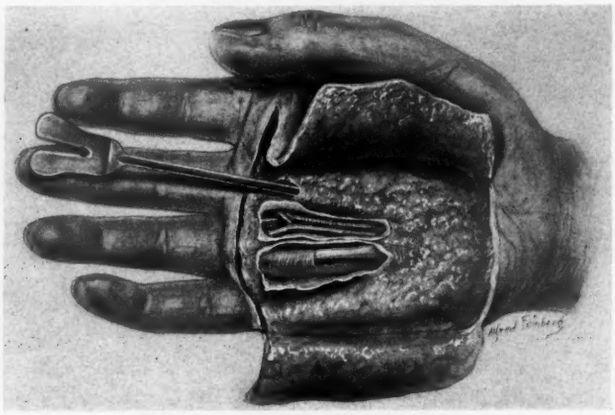

Fig. 1. Dissection of palmar fascia. Longitudinal incisions are made upon a grooved director inserted under the palmar fascia. One such incision made has exposed the long flexor tendons to the ring finger. Another has exposed the digital vessels and nerve between the ring and middle fingers. (Skin incisions shown are for clarifying steps in the procedure.)

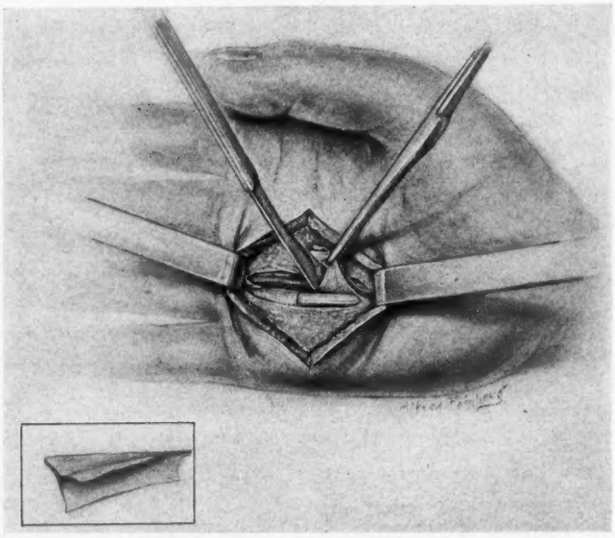

Fig. 2. Excision of deep extension with attached portion of palmar fascia. Insert: Resected deep extension with its adjacent palmar fascia.

will represent the line of its attachment to the interosseous fascia.

The number of longitudinal incisions made and, therefore, the number of deep extensions removed will depend upon the individual case. Usually the middle, ring and small fingers are involved in the contracture. This would necessitate six longitudinal incisions: (1) over the long tendons to the little finger; (2) an incision over the canal between the little finger and ring finger; (3) another incision over the long flexor tendons to the ring finger; (4) one over the canal between the middle and ring fingers; (5) another over the long flexors of the middle finger; and (6) one over the canal between the index and middle fingers. In this manner the greater part of the contracted palmar fascia together with five deep extensions would be removed. An additional strip of palmar fascia may be removed from the lateral aspect overlying the tendons to the little finger.

Should the index finger also be involved, two additional incisions would be necessary: (1) over the tendons to the index finger, and (2) over the lumbrical canal on the radial side of the index finger. Practically the entire palmar fascia would thus be removed together with seven deep extensions.

By following this procedure the operating time may be markedly shortened while the maximum amount of contracted fascia can be removed with the least danger of injury to the blood vessels, nerves and tendons.

The following report is of a patient with Dupuytren's contracture who had a marked flexion deformity involving the third, fourth and fifth fingers. The above operative procedure resulted in the correction of the deformity with no recurrence.

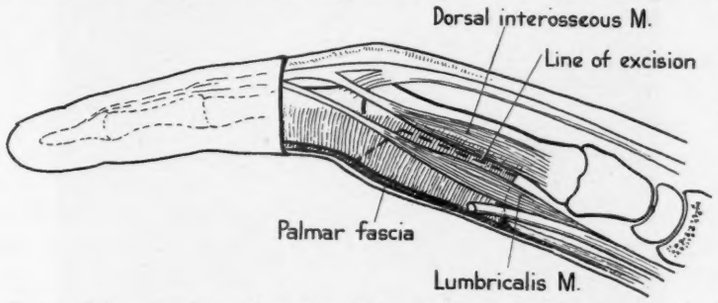

Fig. 3. Diagram shows line of excision of deep extension and attached part of palmar fascia, viewed from the side.

CASE REPORT

Miss C. C., age twenty-four years, gave a history of having had repeated attacks of rheumatic fever starting at the age of thirteen years. Her tonsils had been removed three years before this. During the first attack of rheumatic fever, her knees, ankles, shoulders and elbows were involved but these cleared up after being in bed for six weeks. She was left with a contracture of the third, fourth and fifth fingers of the right hand.

In an attempt to hide this deformity, she used to carry a handkerchief in this hand more or less constantly. She had made no attempt to have her fingers straightened out until she found that this deformity interfered with her social engagements. The rest of her history was irrelevant.

Physical examination revealed a well developed and well nourished, rather attractive young woman with a typical Dupuytren's contracture of the right hand involving the third, fourth and fifth fingers. The joints of these fingers were not ankylosed. With a forceful but unsuccessful attempt to extend these fingers strong contracted fascial bands could be seen and felt under the skin of the palm. The rest of the examination was essentially negative.

An attempt was made to see what improvement would result from active manipulation, stretching, repeated hot and cold soaks, and electric stimulation and massage of the long extensor muscles of these fingers. A corrective glove was designed with pockets on the dorsum of the three fingers for slips of spring steel. After eight weeks of diligent effort along these

Fig. 4.

Fig. 5.

Fig. 4. Shows the contracted fingers before the operation.
Fig. 5. Shows the hand one month after the operation. Note the slight hyperextension of the fourth and fifth fingers now possible, and the linear healed scar in the distal flexion crease of the palm.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

Figs. 6, 7, 8 and 9. Four years after the operation. No recurrence of the contractures. Complete functional restoration of the fingers.

conservative lines no improvement whatsoever was noted and operation was advised.

Under general anesthesia a 2-inch incision was made in the distal palmar crease of the hand. The skin and part of subcutaneous tissue was dissected away from the palmar fascia all around the incision. The palmar fascia was found markedly thickened and contracted. The anatomical locations of the long tendons to the three outer fingers and intervening lumbrical canals were determined, and then each passageway was opened by longitudinal incisions made upon a grooved director first inserted under the palmar fascia as described above. The fascial septae or deep extensions from palmar fascia to interosseous fascia were likewise found thickened and these were completely removed. Four such deep extensions were removed together with the palmar fascia which had covered the lateral half of the palm. There was very little bleeding, and after the resection of the fascia the fingers could be straightened out with ease. The flexor tendons were not lengthened. The incision edges in the skin and subcutaneous tissue were then approximated with interrupted silk sutures, and a volar splint applied.

Manipulation of the fingers was started on the third day after the operation. The patient left the hospital after four days, but was seen frequently at the office during the following three weeks. The patient was given active and passive exercises for her fingers. The wound healed by primary union. The functional correction of the contractures was very satisfactory; the scar in the palmar crease was hardly noticeable.

Four years later there was no evidence of any recurrence of the deformity. (Figs. 4 to 9.)

SUMMARY

1. A procedure for a more complete removal of the palmar fascia and its deep extensions in Dupuytren's contracture is described.

2. A case report is given in which this procedure resulted in complete functional restoration. No recurrence of any contracture was noted after four years.

THE PREPARATION OF SUPERFICIAL WOUNDS FOR SKIN GRAFTING BY THE LOCAL USE OF SULFANILAMIDE AND SULFANILAMIDE-ALLANTOIN OINTMENT*

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THERE are several methods of preparing superficial granulating wounds for the reception of skin grafts. The most successful has been continuous wet dressings or irrigations with normal saline solution and mild antiseptics. These measures require expert management and constant attention. In some parts of the body they are difficult to apply and are annoying to the patient. A more simple and effective method has long been needed. This need seems to have been fulfilled with the introduction of the sulfonamides. The results obtained by the local application of sulfanilamide and sulfanilamide-allantoin ointment in preparing some forty superficial ulcerations for skin grafting forms the basis for this report.

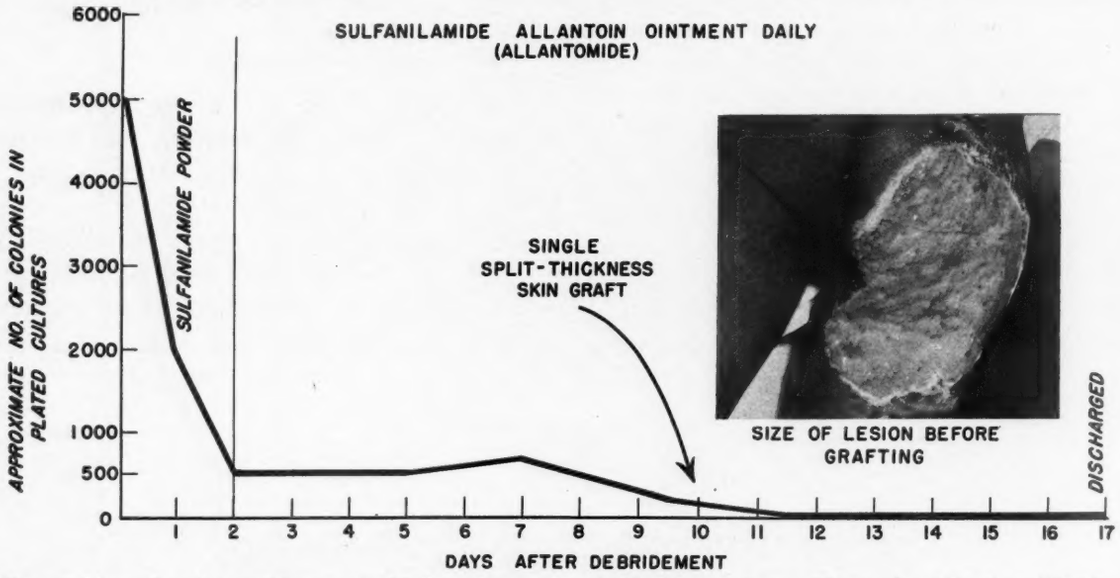

FIG. 1. Chart showing rapid control of infected second and third degree burn of buttocks, following débridement and the topical application of sulfanilamide and sulfanilamide-allantoin ointment. Entire lesion grafted at one stage. Note position and size of lesion on buttocks.

In a large surgical service, such as we have at the Gallinger Municipal Hospital, many cases require the use of skin grafts. These include extensive body burns, traumatic wounds, postoperative skin defects, amputation stumps and chronic leg ulcers. Practically all such lesions are contaminated or grossly infected. The chief aims of treatment should be the control of the infection and the promotion of the natural processes of healing. The healing time of granulating wounds depends upon the size, depth, vascularity, location and the activity of the infecting organisms. Many of the smaller superficial ulcers will heal promptly if they are kept clean and the growing epithelium is protected. The healing time of the larger ulcers may be tremendously shortened by the use of autogenous skin grafts. However, in order to apply skin grafts successfully to such lesions the field must be properly prepared. The bacterial

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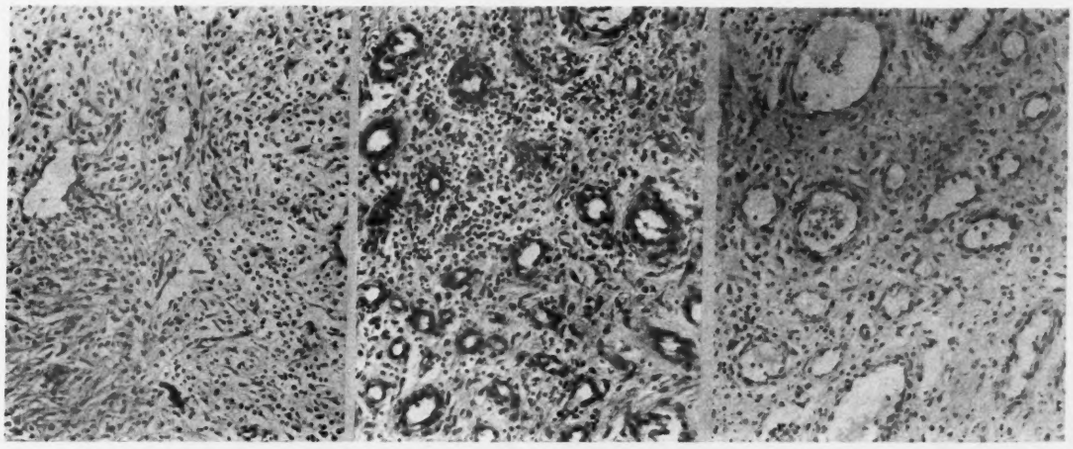
activity, or infection, must be inhibited and an adequate blood supply of the granulating bed promoted. In a recent communication[1] we outlined the technic used in combatting local infection in pyogenic wounds by the topical application of sulfanilamide and sulfanilamide-allantoin ointment. The same routine has been highly effective in controlling the infection in superficial granulating wounds. After proper application of this form of treatment, these wounds have been found to be in an ideal state for the reception of skin grafts.



A B C

Fig. 2. A, photomicrograph of granulation tissue of ulcer after controlling infection by the local application of sulfanilamide. Note the scant number of blood vessels. B, same area of ulcer after ten days' application of 2 per cent allantoin. Note increased vascularity and also the exacerbation of infection. C, same area after being treated by the local application of sulfanilamide-allantoin ointment for ten days. Note the marked decrease in infection with the maintenance of adequate blood supply.

Sulfanilamide, when applied directly to an infected or contaminated wound, inhibits bacterial growth according to the degree of concentration of the drug. Its action is a direct one, and the drug must come into actual contact with the organisms to be effective.[2] This means that the lesion to be treated must be adequately débrided and all parts made accessible. Sulfanilamide inhibits the growth of all the common organisms found in surface wounds. Among these are the various strains of staphylococci, streptococci, the colon-dysentery group, diptheroids and Bacillus pyocyaneus. A single application of the pure sulfanilamide does not sterilize the wound. A fresh supply must be added daily until the infection is completely controlled. Prolonged local use of the pure drug may slow the healing process in granulating wounds by inhibiting the vascularization of granulation tissue and retarding the growth of new epithelium.[1,3]

We have found that by substituting sulfanilamide-allantoin ointment for the concentrated powder after the infection has been controlled active healing will quickly revive. Robinson[4] has previously demonstrated that allantoin has a stimulating effect upon epithelization by increasing the vascularity of granulation tissue. The sulfanilamide-allantoin ointment (allantomide) contains 10 per cent sulfanilamide and 2 per cent allantoin in a special base. This amount of sulfanilamide prevents reactivation of the bacterial growth and yet does not produce a harmful effect on the delicate new epithelial cells. Two per cent allantoin has proved sufficient to promote rapid development of blood vessels in the granulation tissue. The base[5] of this ointment contains stearic acid, triethanolamine and glycerine, which is greaseless and apparently insures complete liberation of both the active ingredients.

The following method has now been used in preparing more than forty cases of superficial ulcerating areas for skin grafts. It has proved highly successful and quite

simple in application. The first measure is that of making the entire surface of the lesion accessible to the local application of

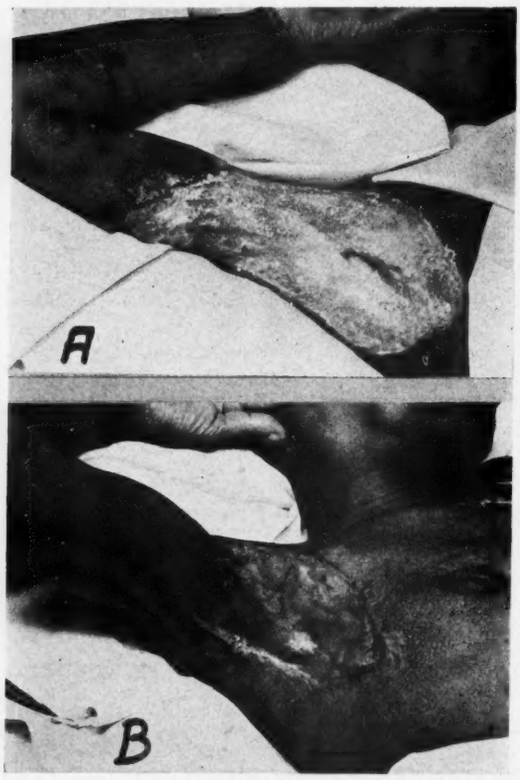


Fig. 3. Intractable furunculosis of axillary pad. Entire area excised; control of infection with sulfanilamide powder; preparation of granulation tissue for skin graft with allantoin-sulfanilamide ointment; successful single split thickness graft. A, showing sulfanilamide powder applied to surface of lesion. B, healed graft.

the sulfanilamide powder. All necrotic and nonviable tissue is removed and all pockets and undermined regions are adequately drained. In the more extensive lesions a suitable anesthesia should be used for this procedure. After hemostasis has been secured a sufficient quantity of the pure sulfanilamide is applied to cover completely the entire surface of the wound. The amount used, of course, varies with the size and character of the lesion under treatment. From 2 to 10 Gm. may be safely used in the grossly infected wounds. The rate of absorption from such lesions is slow and the total amount absorbed into the blood stream is smaller than when the drug is given by mouth or parenterally. We have seen no evidence of any systemic toxic reaction following local application of sulfanilamide or sulfanilamide-allantoin ointment in more than 300 cases of pyogenic wounds. After instillation of the powder the wound is simply covered with a dry gauze dressing. A new dressing with a fresh supply of sulfanilamide is applied daily until the infection is completely controlled. At this stage many of the small ulcerated areas will be found ready for the application of a skin graft. In the case of the larger ulcers and extensive burns, however, the granulation tissue is often pale, anemic and poorly vascularized. Such cases require correction of this deleterious action of the drug before a grafting operation is undertaken. The allantoin-sulfanilamide ointment (allantomide) is very efficacious for this stage. (Fig. 1.) The pure sulfanilamide is discontinued and the granulating surface is lightly covered with the ointment. It may be spread directly upon the surface or applied on a gauze dressing. These dressings are applied daily. Within a few days after beginning the use of the ointment the granulation tissue begins to grow actively and becomes more healthy in appearance. Biopsies taken from such wounds actually show many small new blood vessels growing into the granulation tissue. (Fig. 2.) The bacterial activity remains inhibited. As soon as the granulation tissue becomes bright pink in color and bleeds freely when traumatized, the ulcer is considered ready for grafting. (Figs. 3, 4, and 5.)

We have employed the same immediate operative preparation in all cases. The patients receive a suitable anesthetic. The recipient field is scrubbed with green soap and water. The donor areas are prepared by ether, iodine and alcohol. The granulation tissue is pared down with a sharp scalpel and complete hemostasis secured. Several types of skin grafts have been employed in the present series of cases. In the majority of instances, however, the split thickness skin graft has been used. The Padgett dermatome[6] has simplified the taking of this type of graft and has made it

the most practical of all. By this technic a graft of almost unbelievable size can be used at one operation. The postoperative care of the grafts has varied considerably, but in all cases the grafted part has been immobilized. When the entire granulating surface has been covered at one stage, we have used wet and dry dressings with equal success. In those cases in which only a portion of the lesion was grafted at the first stage we have applied sulfanilamide-allantoin ointment dressings to the ungrafted area while awaiting the next stage. (Fig. 6.)

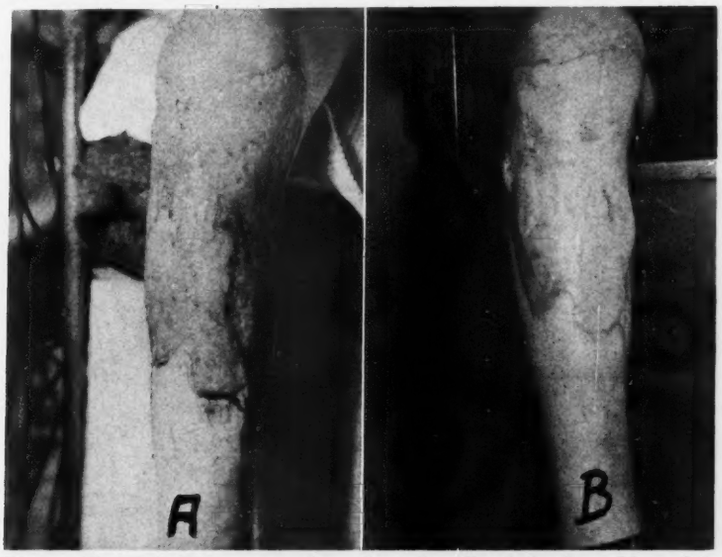


Fig. 4. Extensive streptococcic and gas bacillus infection of leg with skin gangrene. Rapid control of infection by the topical application of sulfanilamide after débridement; granulation tissue prepared by sulfanilamide-allantoin ointment. A, granulation tissue ready for graft. B, successful graft in one stage.

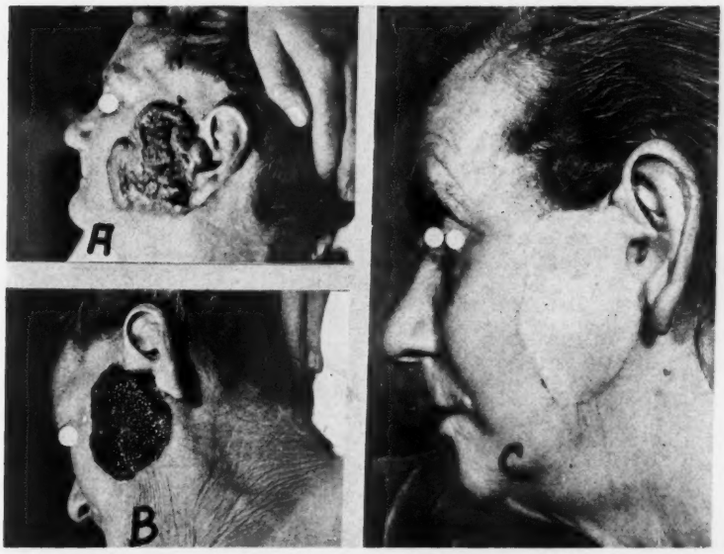


Fig. 5. Carcinoma of face with gross infection; excision; control of infection by topical application of sulfanilamide and sulfanilamide-allantoin ointment. A, carcinoma of face before excision. B, granulation ready for graft. C, healed graft.

This dressing has maintained control of the infection and has not interfered with the "take" of the graft.

SUMMARY

Sulfanilamide has proved to be an excellent local agent in combatting bacterial

growth in infected and contaminated surface wounds. The action of the drug is a direct one and must come into contact with the invading organisms. Prolonged use of the pure drug may retard healing. Complete removal may allow a reactivation of the infection. Both of these disadvantages may be averted by substituting sulfanilamide-allantoin ointment for the pure powder after the infection has been controlled. The allantoin promotes active vascularization of the granulation tissue thereby creating a favorable state for the reception of skin grafts. The excellent results obtained by preparing some forty superficial wounds for skin grafting by the local use of sulfanilamide and sulfanilamide-allantoin ointment (allantomide) has been most encouraging. The method is simple and applicable to all areas of the body.

We wish to thank The National Drug Company, of Philadelphia, Pennsylvania, for furnishing us with the allantomide used in this study.

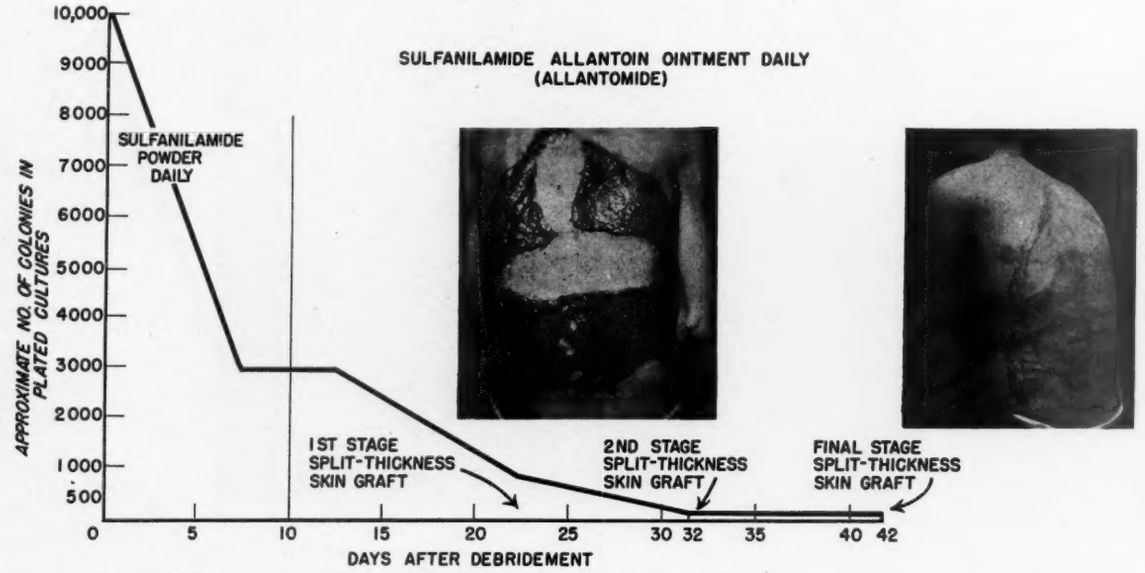


Fig. 6. Chart showing rapid control of infection by sulfanilamide locally in extensive second and third degree burn of back following débridement. Preparation of granulation tissue for skin graft by topical application of sulfanilamide-allantoin ointment. Note size of graft used and the healthy appearance of granulation tissue.

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THE USE OF A PLASTER SLIPPER IN THE MANAGEMENT OF SIMPLE FRACTURES OF THE TOES*

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THE purpose of this article is to present a practical form of light plaster support which affords comfort, protection and relative immobilization for minor fractures of the toes. It is simple to construct, may be removed quickly and reapplied with ease. Many methods have been suggested for attaining these objectives. They vary from simple adhesive strappings to circular plaster casts which include both the foot and toes. The simpler methods frequently do not provide sufficient stability and protection for the broken phalanx. The more sturdy supports provided by plaster boots or malleable aluminum forms seem cumbersome to the patient and are usually time consuming in their application.

FIG. 1. This illustration indicates the method of taking the measurements.

FIG. 2. This photograph shows the method of applying the plaster to the foot.

TECHNIC

Measurements of the foot and ankle are taken from the anterior intermalleolar line over the dorsum of the foot, across the tips of the toes, back beneath the plantar aspect of the foot and heel, and up to the posterior intermalleolar line. (Fig. 1.) Two strips of cotton flannelette four inches longer than the required length and six inches wide are laid out on the plaster table. Strips of plaster are constructed (dry) with four to six inch rolls. The length of the strips correspond with the original measurements taken of the foot. Eight to ten thicknesses of plaster are sufficient. The patient's foot is then carefully bathed, dried and powdered, especially between the toes. Small squares of cotton are placed between the digits. The fractured toe can be further immobilized with crossed adhesive strips, if this seems advisable. The bony prominences of the tarsal bones, the base of the fifth metatarsal, the head of the first metatarsal and the heel are then protected with a few thicknesses of sheet wadding. The plaster is dipped and laid out smoothly

* From the Department of Surgery, The Mary Imogene Bassett Hospital, Cooperstown, New York.

on one of the above mentioned flannel strips. The edges of the flannel are folded along the sides and ends of the plaster in order to cover all rough edges. The strip is then applied to the foot and gently molded to the peculiarities of the individual extremity. (Fig. 2.) When the plaster has begun to harden, an ace bandage is applied evenly and snugly to maintain constant pressure on the mold. It will be found that when fully hardened the plaster can be removed easily by gently separating the dorsal from the plantar portion of the cast. (Fig. 3.) The plaster usually possesses enough flexibility at the toe angle to allow this adjustment without cracking. The mold can be easily replaced and secured with the bandage. (Fig. 4.) If it seems desirable to allow the patient to walk, a wooden block heel and square wooden sole may be placed in the folds of the mold before the plaster is applied to the foot.

Fig. 3. This picture demonstrates the proper method of applying and removing the mold.

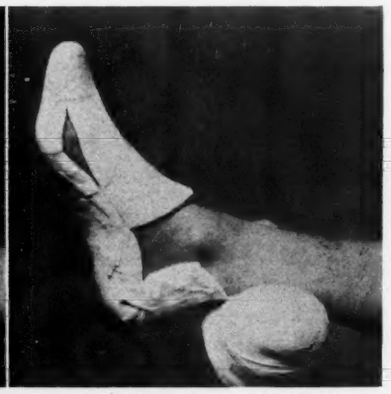

Fig. 4. The above illustration presents the cast molded to the foot.

CONCLUSION

Simple fractures of the toes in which the fragments tend to remain in satisfactory position are not as a rule difficult problems in management. It is, however, important to provide comfort for the patient and stability for the fragments while the healing process is in progress. The type of cast presented in this paper can be worn with comfort, is easy to apply and affords the fractured phalanx adequate protection and support.

Case Reports

OBSTRUCTION OF THE COMMON BILE DUCT BY A DETACHED PIECE OF LIVER*

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IT is most unusual to find a detached piece of liver so firmly wedged in the ampulla of Vater that it produces both an obstructive jaundice and a persisting external biliary fistula. The pathogenesis of this bizarre complication is so easily understood when viewed in retrospect.

CASE REPORT

Mrs. M. McD., a stenographer, forty-two years of age, entered the hospital because of an "acute abdomen." During the past five years she had had recurrent attacks of flatulence, indigestion and mild, colic-like pains in the right hypochondrium. Four days previous to entering the hospital, she was seized with persistent nausea and vomiting. Palliative treatment proved ineffective.

Physical examination gave evidence of a profound toxemia. The lips were excoriated by herpetic ulcers, the tongue was dry and furrowed, and the breath was decidedly acidotic. The entire epigastric area possessed a board-like rigidity and the remaining portion of the abdomen was tympanitic. No peristaltic sounds were audible. The temperature varied from 99.2 to 103.2°F. and there were 18,000 leucocytes with an 88 per cent neutrophilic count.

Emergency treatment consisted of gastric decompression, inhalation of oxyen, hot fomentations to the entire abdomen, morphinization, and the intravenous administration of 3,000 cc. of 5 per cent solution of glucose in physiologic saline. Even this rigorous therapy failed to arrest the storm and an immediate laparotomy was advised for fear that the gallbladder had undergone gangrenous changes and perforated.

The peritoneal cavity was opened through a right rectus incision and a large, tense, acutely inflamed gallbladder immediately presented itself. The common bile duct was enlarged and indurated but no stones could be palpated. The pancreas was swollen, firm and edematous. Fifty-five cc. of thick purulent bile were aspirated from the gallbladder and on opening this decompressed viscus, its gangrenous mucosa was found to be completely detached from the underlying muscularis. No difficulty was experienced in extirpating the necrotic membraneous lining as it came away *en masse*, forming a distinct cast of the gallbladder cavity. Five facetted stones were removed from its lumen, one of which had become impacted into the orifice of the cystic duct. Digital exploration revealed an ulcerative perforation of the posterior wall of the gallbladder and two small stones were removed from the contiguous liver abscess. The patient's condition was so serious and the cholangitis and pancreatitis were so extensive that further exploration seemed unwarranted, therefore, a simple cholecystostomy was performed.

The immediate postoperative course was most pleasing except that the stools remained acholic for all the mucopurulent bile escaped from the external fistula. This was not unexpected as the inflamed pancreas was capable of producing a compressive occlusion of the ampullic portion of the common bile duct. In order to obtain accurate information concerning the functional status of the biliary tree a deferred cholangiogram was made on the eighth postoperative day. The gallbladder and cystic duct appeared to be normal but the ampullic segment of the choledochus was obstructed so that the contrast fluid could not enter the duodenum. The location and contour of the occluding lesions strongly suggested the presence of a stone. (Fig. 1.)

* From the Surgical and Medical Departments of the Latter Day Saints Hospital, Salt Lake City, Utah.

Several attempts were made to dislodge the calculus by means of the "biliary flush." Physiologic doses of amyl nitrite and atrophine sulfate were given to relax the sphincter of Oddi, following which the common bile duct was subjected to positive pressure lavages with warm olive oil. The results were most disappointing. As Best and Hicken[1] had successfully employed the biliary flush in other cases it was believed that our failure was due to an extensive pancreatitis producing a compressive occlusion of terminal choledochus. The patient was permitted to go home; we hoped that prolonged T-tube drainage would permit the cholangitis and associated pancreatitis to subside.

Four weeks later she was re-admitted to the hospital complaining of chills, fever, colicky pains and jaundice. Copious quantities of purulent bile drained from the T-tube. The soft tissues in the right hypochondrium were swollen, tender and very painful. A curved hemostat was passed along the outer margin of the drainage tube until it entered the subhepatic abscess which was easily evacuated. Ten days were required for the toxic reactions to subside. During this interval, she received intense vitamin therapy and two transfusions of whole blood. A second exploration was deemed advisable.

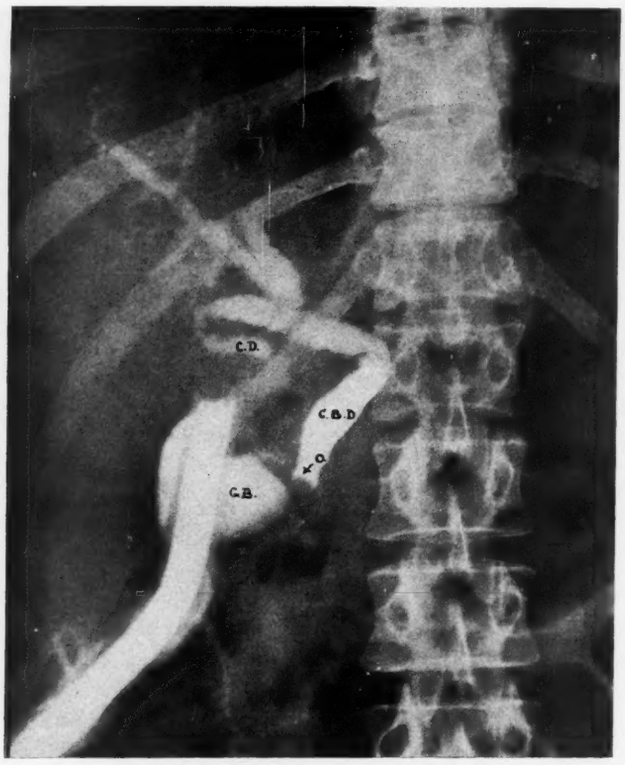

Fig. 1. Postoperative cholangiogram visualizes the gallbladder (GB), the cystic duct (CD), and the dilated common bile duct (CBD). The contrast fluid could not enter the duodenum because of an ovoid filling defect which completely obstructs the ampulla of Vater (O). Calculus?

When the patient was on the operating table, 45 cc. of diodrast* was injected into the cholecystostomy tube. The gallbladder, cystic duct, hepatic abscess and all the dilated bile ducts were clearly visualized. The ampulla of Vater contained an irregular ovoid "filling defect" which was thought to be an obstructing calculus. (Fig. 2.)

The common bile duct was opened and two pieces of bile-stained tissue were removed from its lumen. No other obstructive lesions could be detected, hence a T-tube was placed in the duct and a second operative cholangiogram was made. This revealed the common bile duct to be patulous for the contrast fluid had already

* Diodrast (70 per cent by weight volume) supplied by the Department of Medical Research of the Winthrop Chemical Company.

passed into the duodenum. (Fig. 3.) The gallbladder was removed in a retrograde manner and the perforation of its posterior wall was clearly demonstrated. The contiguous liver substance was necrotic, shaggy and was covered with plastic exudate. Apparently this was the origin of the migratory pieces of liver which plugged the common bile duct.

The convalescence was uneventful and very rapid. A deferred cholangiogram was taken on the eighth postoperative day and all the bile ducts were found to be functioning normally. The T-tube was, therefore, removed and the external sinus closed within the next three days. She returned to her former occupation on the eighteenth postoperative day.

The pathologist's report was as follows: "Two pieces of bile stained tissue measuring 1½ cm. × 5 cm. and ½ cm. × ¾ cm. were removed from the common bile duct. Their outer surfaces were covered with a thick, well organized plastic exudate while the central portion was made up of firm organized tissues. Histologically they represent fragments of liver tissue. The central group of cells seemed viable but the outer layer was necrotic and degenerating. There was no evidence of calcification or stone formation. The tissues were impregnated with biliary pigments."

DISCUSSION

The clinical course is easily understood when all facts have been accumulated. The gallstones apparently obstructed the cystic duct, thus producing an acute hydrops. The concomitant infection, distention and vascular stasis initiated thrombosis and gangrene of the mucosal tissues with perforation of the gallbladder wall. The subhepatic abscess permitted the necrosis and fragmentation of the contiguous liver cells. Two pieces of liver tissue became detached, floated through the perforative opening into the lumen of the gallbladder, along the patent cystic ducts into the choledochus and finally lodged in the ampulla of Vater. The occlusion of the common bile duct accounted for both the jaundice and the persisting fistula.

This case clearly demonstrates the value of operative and deferred cholangiograms. The former provides an accurate pattern of the bile ducts and clearly visualizes all types of troublesome obstructions.[2] This permits the surgeon to plan intelligently

Fig. 2. Forty-five cc. of diodrast (70 per cent) were injected into the external fistula while the patient was on the operating table. The cholangiogram visualizes the gallbladder (GB), patent cystic duct (CD), subhepatic abscess (SA) dilated common bile duct (CBD), and obstructive occlusion of the ampulla of Vater (O). Note that the obstruction is incomplete as the diodrast is seen in the duodenum (D), and the jejunum (J).

corrective procedures and obviates many unnecessary ductal explorations. Every patient submitting to a cholecystostomy or choledochotomy should have a complete cholangiographic study before the drainage tubes are removed. If the ductal patterns are normal, an uneventful convalescence can be anticipated. If, however, definite obstructive lesions are recognized, the patient should be appraised of such undesirable complication and plans should be made to remove the obstruction as soon as conditions are favorable. It seems most unwise to wait for jaundice, cholangitis, pylephlebitis and hepatic insufficiency to develop before advising the secondary exploration. These undesirable complications are responsible for the high mortality rate associated with re-operations on the biliary tract.

SUMMARY

1. Following a cholecystostomy for a gangrenous gallbladder with perforation the patient developed a subhepatic abscess, jaundice and an external biliary fistula. Cholangiographic studies demonstrated a "filling defect" in the ampulla of Vater which produced complete choledochal obstruction. Two pieces of liver substance were removed from the terminal segment of the common bile duct. These detached fragments of liver apparently sloughed off from the margins of the hepatic abscess, floated through the perforative opening into the gallbladder, through the cystic duct, into the common duct where they became impacted in the ampulla of Vater.

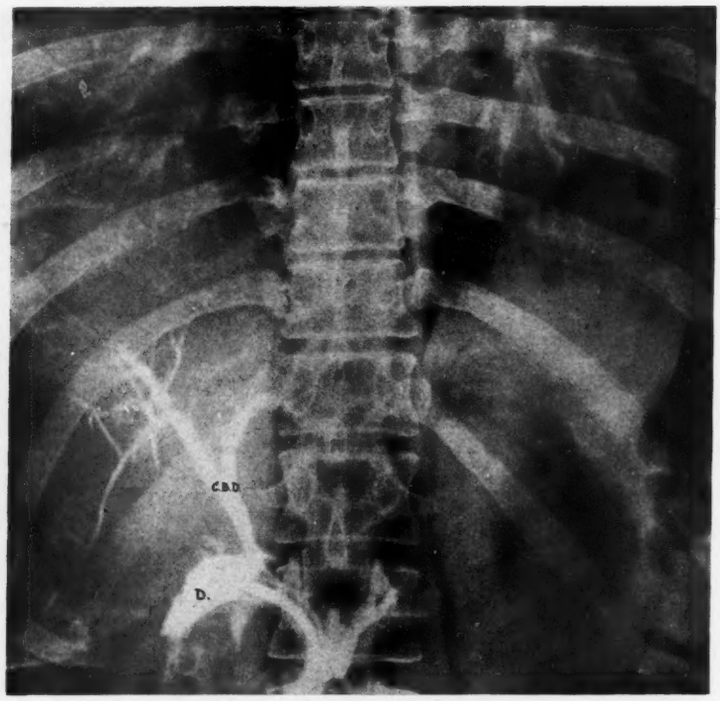

FIG. 3. Second operative cholangiogram made by injecting diodrast into the T-tube after the gallbladder had been removed and while the abdomen was still open. The extrahepatic bile ducts were patulous permitting the diodrast to enter the duodenum immediately (D). The ampullic obstruction which consisted of two detached pieces of liver had been removed.

2. The value of operative and deferred cholangiograms in detecting endocholedochal obstructions is clearly demonstrated.

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SUBCUTANEOUS RUPTURE OF MECKEL'S DIVERTICULUM

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SUBCUTANEOUS rupture of the bowel by blunt force is not an unusual occurrence, but rupture of a Meckel's diverticulum under similar conditions is very rare. A fairly complete search of the literature over the past twenty years does not yield a report of a single incidence.

Subcutaneous rupture of the bowel can occur in three ways: Moty's classification, which has been generally adopted, is first by crushing, second intestines are torn and third the intestines may be burst by pressure within its lumen. This force may be by direct or indirect violence or by muscular action. Direct violence is well illustrated by the kick of a horse, the jabbing of a plow handle, the sudden striking of a blow by a piece of timber or the crushing incident to being run over by a car. That by indirect violence is more often by a fall in which there is more direct trauma to the abdomen, and secondly and least frequent is occurrence by the sudden compression of a loop of bowel filled with gas. While most writers seem to think that this is relatively rare, we believe that if one takes into consideration the laws of physics, this is an element which plays a most important rôle in the majority of ruptures.

The stomach and large bowel are comparatively immune to injury, no doubt on account of their being in a protected location. Most ruptures occur in the small bowel and are said to be near some point of fixation. However, our observation in six cases has been that they occur in a fairly mobile section of the intestine. It is a fact that they are usually in the ileum or the jejunum which is explained by these points of the gastrointestinal tract occupying a fairly uniform relation to either the spine or promontory of the sacrum, and that in either instance the bowel is crushed between the force and the spinal column or the promontory of the sacrum. The direction of the trauma has also a good deal to do with the nature of the injury to the bowel and the portion of the intestinal tract involved. In other words, a direct blow impinging the bowel from a fixed point is fairly uniform in affecting either the lower ileum or the jejunum, while an injury from an oblique force will be determined mainly by the direction of the force and the obstacles which it encounters.

The danger zone of the abdomen lies in the exposed region between the symphysis and the costal margin in that here there is no protection except for the soft parts of the abdominal wall, and most injuries of this character occur in this region.

Ordinarily, there is a history of an injury, the presence of pain, shock, muscular rigidity, nausea with some vomiting and, the most diagnostic of all is the presence of free air in the peritoneal cavity as demonstrated by the *x*-ray. Later there is an increase in the leukocyte count, abdominal distention and those symptoms incident to a progressive peritonitis.

The mortality rate is high, some place it as high as 75 per cent to 80 per cent. This is due mainly to the delay in recognition of the pathology present. Sometimes it seems as if all factors conspire against an early recognition of such an injury. First, there is usually the delay in seeking medical advice; later there is a further delay in attempting to evaluate properly the symptoms to reach a correct diagnosis.

Treatment. The first procedure is to combat shock, and secondly, early operation is the one most important factor in treating these patients. If one waits for the development of symptoms, a general peritonitis and death are almost certain

sequelae; therefore, if there is any doubt as to whether or not there is an intra-abdominal lesion present, we have come to the definite conclusion that an exploratory laparotomy is imperative.

The case, which is the basis for this report, was that of a patient struck in the abdomen by a plow handle and it is unique from three points of view: First, the opening was only pinhole in size; secondly, it was probably due to the bursting forth of gas in the lumen of the bowel, and third it occurred in a Meckel's diverticulum.

CASE REPORT

S. A., age sixteen, healthy, while plowing was struck in the abdomen near the umbilicus with the handle of a plow at about 10 A.M. June 15th. He suffered immediate severe pain, so severe that he walked only about thirty feet and was then taken home. At 3 P.M., five hours later, he was taken to a physician who immediately referred him to the hospital where he was admitted at about 5 P.M.

Physical examination showed a well developed youth of sixteen. Heart and lungs were normal, abdomen was rigid with general soreness but he complained of the most severe pain in the right lower quadrant. He had suffered some from nausea at the outset and had vomited once. His blood count showed 16,500 leukocytes with 82 per cent polymorphonuclears. An *x*-ray of the abdomen was not made because of the characteristic history which would necessitate exploration.

At 6.30 P.M. a low midline incision was made and there was immediate evidence of peritonitis, the lower ileum being congested, distended and having flakes of adherent mucus upon it. There was also present a thick, dark, yellowish fluid exudate around the cecum, in the pelvis and in Morrison's pouch. The small bowel was carefully examined from the ileocecal valve to the duodenum without finding a perforation. A Meckel's diverticulum about two and one-half inches long was found about three feet from the ileocecal valve but apparently was healthy, and on account of the seriousness of the condition present it was decided to leave it alone. The large bowel and the stomach were then carefully examined throughout with still negative results. The small bowel was again gone over without finding the presence of a leak upon either the mesenteric or antimesenteric borders. The Meckel's diverticulum was again picked up and examined, firm pressure being made upon its base when there could be distinctly heard the whistle of the escaping air from a pinhole opening in its distal extremity.

The omphalomesenteric vessels were ligated, the diverticulum divided between clamps, phenolized and a running overhand suture inserted; the clamps were removed and the sutures tightened, tied and reinforced by purse-string sutures of fine linen. An enterostomy with a mushroom catheter was then made about six inches proximal to the diverticulum, the appendix was removed and a large Penrose tube introduced into the pelvis and brought out through a stab wound just above the pubis. On account of the escape of the intestinal contents into the peritoneal cavity the wound was treated by the open technic. Continuous intravenous glucose was started immediately, the patient placed upon his abdomen in bed and a therapeutic dose of antigangrene serum administered. The further course of this patient was without any untoward development.

The pathological report was as follows: The appendix is 56 mm. long. The specimen of bowel is 30 mm. long. It is a diverticulum and near the end is a little bulged part with a pin-point opening in it. Sections of the diverticulum show the distal portion congested, edematous with a rather dense polynuclear infiltration, especially just under the serosa. The mucosa is a tall villeous type with an edematous and congested stroma. There is no gastric mucosa. The appendix shows a slight congestion with only a round cell infiltration in the mucosa and submucosa. Diagnosis: Acute diverticulitis with perforation; chronic appendicitis.

THE MIGRATION OF PROJECTILES IN BLOOD VESSELS*

REPORT OF AN UNUSUAL CASE

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MANY interesting cases of migration of bullets and foreign bodies through the channels of the circulation, both arteries and veins, have been reported. To this group we wish to add an unusual instance of migration of a bullet through the arterial system.

CASE REPORT

Mr. A. M., a Filipino, twenty-six years of age, was admitted to Stanford Lane Hospital January 16, 1935. He was shot at 10:15 P.M. and seen at 10:30 P.M. The boy was rather frightened but in good physical condition. He was shot with a twenty-five calibre pistol at a distance of two yards. The patient threw his left hand and arm in front of his body to ward off the blow. Only one shot was fired. The patient fell to the floor when shot, then walked to a taxi and was brought to the hospital. Physical examination showed three bleeding puncture wounds, two in the left arm, one in the left thorax located as follows: one about one inch above the left elbow anterolaterally, one about six inches higher on the arm anteromedially, and the third in the left thorax at the level of the second rib at a line of the outer and middle third of the clavicle. There was slight bleeding but no sucking thoracic wound. The wound in the chest was clean cut, circular and showed no carbon marks. There were no motor or sensory changes in the left hand or arm. The left pulse was much weaker than the right. Examination of the chest revealed dullness and absence of breath sounds about three inches higher on the left than right back. Respirations were 30 per minute, and the pulse rate was 76. The patient had a feeling of faintness and shortness of breath. The wounds were treated with 4 per cent iodine and sealed, and the patient was sent for *x*-rays.

Fluoroscopic examination failed to reveal a bullet in the thorax. No fluid level was made out. A high diaphragm was seen on the left.

Fluroscopic and *x*-ray examination early the following morning showed the bullet to be in the left thigh just below the groin. At this time the dorsalis pedis pulse was good and there was no pain in the leg. His left leg appeared to be slightly larger than the right and felt warmer. There was no hemorrhage.

He was prepared immediately for operation. The bullet was located by *x*-ray before operation by means of a lead square placed on his leg. The position was marked out with acriflavin. Dr. Emile Holman was the surgeon. Under local anesthesia a skin incision about 10 cm. long, immediately over the femoral vessels, was made through the full thickness of the subcutaneous tissues. The femoral artery and vein, with their accompanying nerves, were located. These vessels were developed by blunt dissection. After some searching the bullet could be palpated in the proximal portion of the deep femoral artery about 1 cm. from its origin. Two braided silk sutures were passed about the deep femoral artery on either side of the bullet. An incision about one-third of the diameter of the vessel was made through its wall and the bullet delivered. An unsuccessful attempt was made to suture the incision in the artery. The artery was then divided, ligated and transfixed with double medium black silk. The subcutaneous tissues and skin were closed. The bullet showed no bone markings.

His postoperative course was quite uneventful. Several chest films were made and on the first postoperative day a moderate amount of fluid appeared in the left chest. Fifteen days after the operation, on discharge from the hospital, the amount of fluid at the left base had decreased to a very small amount and the diaphragm had become lower.

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We have followed this patient from time to time in our Out-Patient Surgical Dispensary since his dismissal. At the present time, five and one-half years after the accident, he is perfectly well.

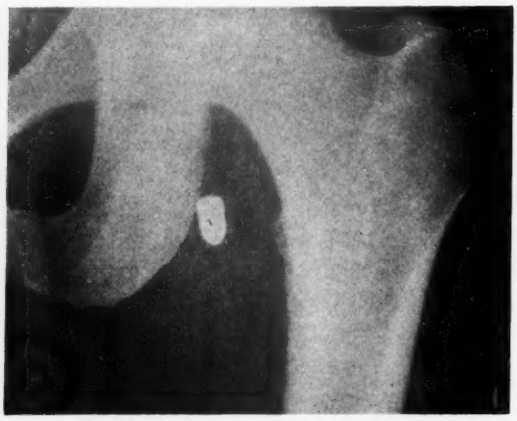

Fig. 1. Photograph of *x*-ray showing bullet in the left deep femoral artery.

Our conclusions of the mechanism are as follows: It seems most probable that the nearly spent bullet entered directly into the subclavian artery in a well supported location and carried the adventitia into the rent. As the invaginated vessel wall came back to its normal position, the opening was closed. The weak pulse was due either to spasm of the injured vessel or to the tissues carried in. The right and left pulses were of equal strength fifteen hours after injury.

In reviewing the literature on the migration of projectiles in blood vessels, four cases were found to have been reported similar to the one presented here: de Roualt relates the case of a soldier who had been shot in the arch of the aorta; the missile dropped into the left femoral artery causing an ischemic paralysis and gangrene of the limb, followed by death. Bland-Sutton reports a case of a soldier wounded in the chest. Four pints of blood were evacuated from the chest and the wound closed. Streptococci were obtained in the culture and the man died on the fifth day. At autopsy a small wound was found in the aorta just below the arch and the bullet embedded in firm clot in the external iliac artery. Boechel reports that a bullet, previously localized by fluoroscopic screen in the left heart, was found obstructing the femoral artery, where it caused gangrene of the limb requiring amputation. Piedelievre reports a case in which the bullet entered the chest to the right of the sternum. The patient died of a pericardial effusion. At autopsy the bullet was found in the left femoral artery at its bifurcation, having pierced the superior portion of the pericardium and then entering the aorta.

Many interesting cases of the migration of projectiles in the heart and blood vessels are summarized in Keen's Surgery. There are several papers discussing the experimental evidence of the varied migration of shot, rice, and other foreign bodies introduced into the arteries and veins, as a result of their migration into the heart and lungs, as well as studies of the weight and size of the foreign body, force of gravity and of posture. Experimental workers in this field have proved that under ideal circumstances bullets can be made to enter the lumen of a rubber tube, in which a water pressure has been established equal to the blood pressure in the aorta, after penetrating only one wall, as long as this tube is supported posteriorly. They have shown that gravity, posture, the specific gravity of the foreign body and the blood flow are all factors in the direction of the migration within the vessel. These result in rather remarkable and, in some instances, incredible migrations of the foreign body from the original site of injury, causing one to wonder how the victims survived their wounds.

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MULTIPLE SHELL WOUNDS

A CASE REPORT

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THE case report which follows presents several points of interest. The injuries caused by a shell explosion are similar to war wounds; the extent to which fluids were forced is somewhat unusual; the successful prevention of infection in the multiple wounds contributed materially to the outcome and the loss of blood type during the course of treatment introduced a very troublesome factor.

CASE REPORT

The patient was a well developed, muscular, white male, age thirty-five. He was admitted to the emergency room of St. Peter's Hospital, New Brunswick, New Jersey, December 27, 1939. The injuries were due to the explosion of an artillery shell which was actually in his hands at the time of detonation. On admission the patient was conscious, but in extreme pain and morphine sulfate gr. ¼ was administered liberally. Superficial examination revealed an almost complete traumatic amputation of the left hand and right foot and a compound comminuted fracture of the right tibia. The skin, subcutaneous fat and superficial musculature of both thighs medially, from knees to the perineum, had been torn away. The scrotum had been partially torn away and the remainder suffered a second degree burn. A gaping wound was visible adjacent to the anal orifice. The face was lacerated and burned as well as the eyebrows, eyelashes and hair over the frontal area. A tourniquet was immediately applied to the right leg and a sphygmomanometer cuff placed around the left arm. Blood pressure was exceptionally good (100/50) and pulse rapid (140) but of good quality.

Immediate treatment included application of external heat, administration of combined tetanus and gas gangrene antitoxin. Glucose 50 per cent (50 cc.) was given intravenously followed by a venocysis of 10 per cent glucose in saline. Visible bleeders were ligated and wounds irrigated with lavish amounts of preheated saline. Copious saline-soaked dressings were applied and the patient admitted to the surgical service of Dr. James L. Fagan. Shortly after admission 500 cc. of citrated whole blood was given.

After four hours dressings showed an appalling amount of oozing. The pulse had lost its initial quality, respirations were labored and blood pressure had fallen to 80/40. The Trendelenburg position was increased and both adrenalin and caffine sodium benzoate administered. Venoclysis of glucose in saline was repeated.

An additional four hours (eight after admission) warranted another half liter transfusion, which was followed by a severe chill. Sodium bicarbonate orally was used to forestall renal block. In two hours 16 ounces of clear urine, (microscopically) voided spontaneously dispelled our anxiety. Surgery was deferred due to the condition of the patient.

The following morning the right leg was amputated at the junction of the proximal and middle thirds employing light cyclopropane anesthesia. The left hand was amputated at the wrist. The medial thigh wounds were débrided and the patient returned to his room in a fair condition.

The forcing of fluids was continued and four hours postoperatively the patient spontaneously voided 26 ounces (780 cc.) of urine. Computation of twenty-four hour fluids revealed a total intake of 11,270 cc., viz 50 cc. of 50 per cent glucose, 1,020 cc. of citrated whole blood, 1,500 cc. of 5 per cent glucose, 5,300 cc. of normal saline and 345 cc. of liquids orally. This wholesale administration of fluids is not presented as a routine method of therapy, for the disastrous results to a weakened myocardium or damaged glomerular system can readily be appreciated. However, having been given ample evidence of a well functioning cardiorenal system we felt justified in pushing fluids as we did.

On the first postoperative day forcing of fluids was continued. The patient's temperature

rose steadily and there was evidence of weakness. An additional transfusion was given, but the laboratory advised that instead of the usual clear cut typing, a slight agglutination occurred when cross-matched. A severe chill followed shortly after transfusion. The chills ceased after administration of 1 ampule of amyl nitrate per inhalation and nitroglycerin sublingually. At this time the patient became violently irrational. His temperature rose to 106°F. axillary (which was twice checked) pulse 144 and respirations to 136.

On the second day removal of dressings disclosed a thick discharge from the thigh wounds. This was extremely malodorous. Copious quantities of hydrogen peroxide were used for cleansing. The wounds were dressed with azochloramid-soaked compresses in which were incorporated five-tube Dakin tubes. The scrotum was supported with wide adhesive strips (Bellevue Bridge) and was also dressed with azochloramid compresses as was the pararectal wound. The nursing staff was instructed to instill the solution into the Dakin tubes twice daily and soak all other dressings with azochloramid. On the face, application of sterile vaseline were adequate.

During the second twenty-four hours the patient received a total of 8,890 cc. of fluids. Urinalysis at this time was essentially negative.

An additional transfusion was contemplated but all previous type specific donors failed to cross-match and showed a dangerous amount of agglutination. The recipient was retyped and it was discovered that he was no longer Type IV (Moss); in fact, his blood no longer fell into any specific type. The apparent change of type was probably a loss of specificity and transfusion had to be deferred because of this complicating factor.

Smears indicated the presence of both staphlococci and streptococci in the various wounds and these findings were confirmed in cultures. Sulfanilamide (gr. 15) was administered every four hours. That night the patient became irrational and tore off all dressings. Sodium luminal intramuscularly was given to avoid self-injury. On the sixth postoperative day it was necessary to use restraints to control the patient. Believing that absorption of large quantities of toxic material might explain this behavior, further transfusion was advised despite imperfect cross-matching. One-half liter of whole blood was administered and despite several chills general improvement followed. Within twenty-four hours the patient cleared up mentally; he was able to take a soft diet and for the first time had a spontaneous bowel movement.

The administration of sulfanilamide was discontinued after ingestion of 540 gr. to avoid deleterious hemopoietic retardation. A blood count warranted our action. Hemoglobin had been reduced to 35 per cent, erythrocytes 2.13 million, leukocytes 19,300 with marked left shift. Other blood findings indicated evidence of achromia, polychromasia, anisocytosis and poikilocytosis.

In view of the difficulty with transfusion, iron medication by mouth was instituted, supplemented by liver extract as well as vitamins B_1 and G. By the twenty-sixth day all wounds were gratifyingly clean and the thigh wounds appeared ready for grafting. Despite this the patient's temperature began rising and an abscessed area was discovered in the gluteal region. Using Hilton's technic the area was drained and 1200 cc. of purulent material expressed. Uterine packing soaked in azochloramid was employed and the skin margins protected by zinc oxide ointment. On the thirtieth day the blood picture showed sufficient improvement to permit extraction of several teeth which had been broken by the impact of the explosion. By the fortieth day the need for further transfusion became imperative and to our gratification cross-matching was again possible. The patient's condition had improved to the point at which massage and passive exercise were possible by the one hundred and fortieth day. All wounds had healed completely with the exception of the right leg stump. One hundred and seventy days after admission he was discharged to the Out-Patient Department for fitting of artificial limb and minor dressings.

SUMMARY

Despite an exceedingly poor prognosis, the ability of the patient to tolerate high fluid intake plus the early control of infection in the wounds due to the employment of azochloramid preparations contributed to a successful outcome.

Loss of blood type while the patient was under treatment proved a troublesome factor which was partially offset by the administration of iron, liver extract and vitamins B_1 and G.

AVULSION OF THE DISTAL TENDON OF THE BICEPS BRACHII

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AVULSION of the distal tendon of the biceps brachii is sufficiently rare to warrant the reporting of each new case. It is far less common than rupture of the tendon of the long head of the biceps. As late as 1931 Platt[15] writing on tendon ruptures in general, was unable to find any record of such a case in surgical literature. Yet Gilcreest[5] made an exhaustive review of the literature, including foreign journals, in 1934 and collected nineteen cases which included rupture and avulsion. To these he added three, one being his own. Since then I have found six additional cases in the American literature in which the distal tendon of the biceps brachii was either ruptured or avulsed. Waugh[20] had two patients with a rupture of the distal tendon, one of which was proximal to the lacertus fibrosus. Since the other patient was not operated upon, it is indefinite as to whether it was a rupture or avulsion. This is mentioned especially because it has been stated in a standard surgical textbook that when the tendon of insertion ruptures it is always a true avulsion. Few textbooks make mention of the lesion at all.

The question of whether or not there was a co-existing pathological condition of the tendon usually arises in injuries of this nature. No cause was found in the literature, but it seems probable that the stress of the muscle contraction is too great for the structures concerned and some point has to give way. Necessarily, there would not have to be pre-existing pathologic changes. However, Donhauser and Kenny[4] reported a case in which there was active inflammation and purulent exudate surrounding the insertion of the biceps tendon. McMaster[11] proved in a series of well controlled experiments on young, healthy rabbits that normal tendons do not rupture. Either the muscle will rupture or the tendon attachment will pull apart.

The diagnosis of avulsion of the distal tendon of the biceps brachii should not be difficult. It nearly always occurs in men over forty. The history is similar to that of tendon ruptures in general. That is, during muscular exertion a sudden snap is heard and felt, simultaneously, with attendant sharp pain located in front of the elbow soon becoming constant and dull. Weakness of the upper arm is immediately noted. The examination usually reveals ecchymosis over the antecubital fossa, the degree of which depends upon the amount of time that has elapsed following the injury. This may extend several centimeters proximal and distal to the elbow. The patient can flex and rotate his forearm but a definite weakness is noted, coupled with a soft bulge in the proximal half of the upper arm. The distal tendon can not be palpated.

Treatment consists of operation as soon as possible. Since little has been written on this condition, the surgeon generally has no precedent to follow and must rely on his own ingenuity. Numerous methods have been employed for reattachment of the tendon. Platt[15] passed the tendon through a hole perforating the radius and sutured it to itself. While making a strong union, it does not necessarily re-establish the original supinating power of the biceps. Sonnenschein[18] raised a trap door in the radius and placed the end of the tendon therein. Gilcreest[5] mentioned two methods; first, Kerschner's, in which the tendon was fixed to the radius with a nail.

Secondly, if this were not possible, he advised suturing it to the neighboring soft structures. Waugh[20] stated that fascial transplant fixation through drill holes in the radius was probably the best method. Rogers[12] used double, heavy braided silk passed through drill holes in the radius and mattressed it in the end of the tendon. Leavitt and Clements[9] scarified the bicipital tuberosity, drilling two holes in the medial projecting margin. Then they inserted heavy silk through one hole and four strands of No. 2-40 day chromic catgut in the other. These were woven into the tendon, pulling it flat against the scarified tuberosity. Bauman[1] made a small incision in back of the upper part of the forearm through which he passed No. 3 plain catgut. The end of the tendon was sutured with one end and the other tied over a gauze pad in back of the forearm. This pulled the tendon down on the radius. Donhauser and Kenny[4] due to acute inflammation in this region, sutured tendon to the antebrachial fascia 3.5 cm. distal to the elbow. They obtained a satisfactory result but do not advise this method in the absence of infection. Another method that has been mentioned is suturing the tendon to the brachialis tendon just before its insertion into the ulna. The lacertus fibrosus should also be sutured. Postoperatively, the arm is put up in flexion and partial supination. The length of time before beginning motion of the elbow varied from two to six weeks in the cases previously reported.

Full function is usually obtained in about two to three months. There is sometimes mild discomfort in the elbow and five to ten degrees limitation of extension. The results seem to be uniformly good regardless of the technic employed.

CASE REPORT

L. Q., a white man, aged forty-two, was admitted to the hospital on the evening of February 5, 1941, complaining of pain in the right arm. His past history was interesting in that he had been accustomed to heavy work all his life, having been a foundry worker until about six months prior to admission. He gave the following history:

FIG. 1. Appearance of the right arm prior to repair of the avulsed tendon.

About 9 A.M. February 4, 1941, with his right hand he picked up a scuttle of coal weighing between fifty to seventy pounds. As he flexed his forearm to an angle of about 100 degrees he felt a sudden sharp pain in front of the elbow, simultaneously hearing a noise similar to that when a piece of gauze is torn. There was immediate weakness of his arm and pain radiating from the middle of the forearm to the shoulder. His forearm gradually extended because he was unable to release his grip on the scuttle. The immediate pain was followed by soreness throughout the arm. At 6 P.M. the following day he was sent by his physician to the hospital with a diagnosis of "strained ligament, severe." At this time his symptoms were soreness and weakness of the right arm.

His general physical examination was essentially normal except for obesity. His height was sixty-six inches and he weighed 197 pounds, unclothed. Blood Kline and Mazinni reactions were negative. Inspection of the right arm revealed ecchymosis on the anterior surface from just beneath the antecubital fossa to the junction of the middle and upper third of upper arm. There was tenderness over the usual course and attachment of the distal tendon of the biceps brachii. On contracting the biceps a large, soft lump formed in the proximal half of the upper arm and the distal tendon could not be palpated. (Fig. 1.)

A diagnosis was made of avulsion or rupture of the distal tendon of the biceps brachii, and on February 7, 1941, an operation was performed under inhalation anesthesia. A midline

incision was made on the anterior surface of the upper arm from the middle to about two inches above the antecubital fossa. On incising the tuberosity was exposed, revealing that the periosteum was stripped from the bone and frayed for a short distance. The synovial bursa

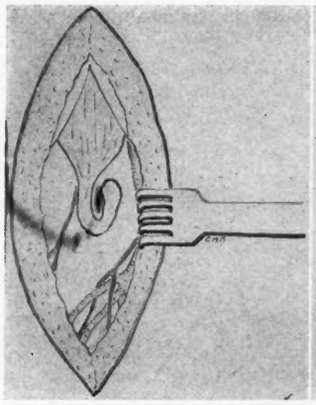

Fig. 2.

Fig. 3.

Fig. 2. Diagram showing the position of the tendon as found at operation.

Fig. 3. Diagram showing position of tendon after attachment to the bicipital tuberosity.

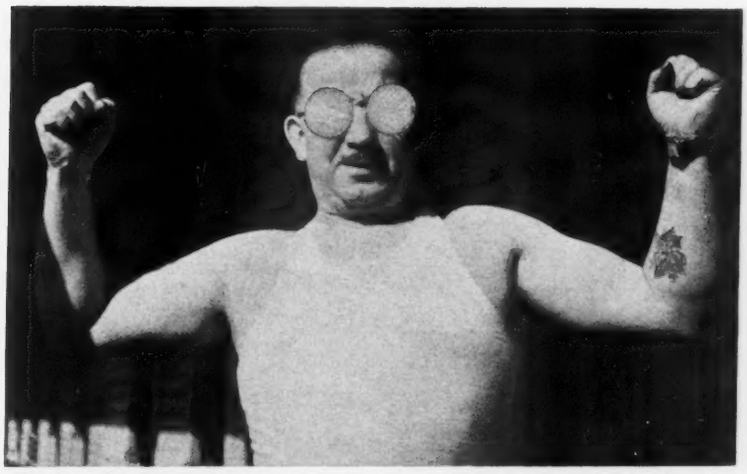

Fig. 4. Photograph of patient seven weeks postoperatively showing normal contour of right arm.

brachial fascia a moderate amount of recently extravasated blood escaped. The fascial incision was lengthened and lying beneath this in the upper part of the wound was the distal tendon of the biceps brachii. (Fig. 2.) The tendon was coiled upon itself, the end being smooth and bulbous with a small hematoma on the surface of attachment. The lacertus fibrosus was torn and frayed.

Of necessity the incision was extended into the upper part of the forearm. The median basilic vein, branches of the recurrent radial artery and anastomosing branches of the brachial vein were ligated allowing retraction of the median nerve, brachial artery and veins medially. Then the pronator teres was retracted medially and by blunt dissection the bicipital was not found. Due to the man's obesity the wound was quite deep. A drill hole was placed into the bicipital tuberosity on each side after the forearm had been fully supinated. The tuberosity was then roughened with a small osteotome. Then a strand of No. 2-40 day chromic catgut was inserted through the bone and passed through the tendon, whose surface of attachment had first been freshened, in such a way that it was pulled tight. The neighboring soft tissues were sutured to the end of the tendon with No. 0 chromic catgut. The latter part of the procedure had to be performed with the forearm flexed to about 95 to 105 degrees in order to relieve tension on the sutures, which, along with the depth of the wound, made working tedious. An attempt was made to repair the

lacertus fibrosus but it was so badly torn the sutures would not hold. The wound was closed, using catgut for the brachial fascia and interrupted vertical mattress sutures of dermal for the skin.

The arm was fixed in acute flexion at the elbow with a posterior plaster splint and taped to the chest. Active motion of wrist was started on the second postoperative day. On the twelfth postoperative day the tape was removed and skin sutures taken out. The wound had healed by first intention. Using a metal splint, the arm was then fixed in ninety degrees flexion and active motion of shoulder was begun. On the twenty-ninth postoperative day the metal splint was removed and a sling used. Active rotation of forearm along with the shoulder motion was encouraged. During the fifth week, infra-red, massage and passive motion was started along with weak galvanic stimulation of the biceps. By the end of the sixth week, postoperatively, there was normal motion of the shoulder with less than five degrees limitation of extension at the elbow. There was no visible atrophy. On contraction of the biceps the distal tendon was definitely palpable as a tense cord in the antecubital fossa. The patient was able to use the arm freely except for heavy lifting and complained of no discomfort. Figure 4 shows a photograph taken seven weeks postoperatively.

SUMMARY

1. Avulsion of the distal tendon of the biceps brachii is a rare injury.

2. The various methods of repair are briefly mentioned.

3. The method of simple attachment to the radius gives good results.

4. A new case is reported.

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PSEUDOFRACTURE OF THE TIBIA

REPORT OF TWO CASES

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IN 1939, Roberts and Vogt[1] first called the attention of the medical profession to an unusual type of lesion occurring in the upper third of the tibia and sometimes found to be bilateral. Because the lesion resembled an incomplete fracture line with periosteal bone proliferation, the disease entity was called "pseudofracture of the tibia." Both of these authors realized that in spite of the appearance of a fracture-like line, trauma *per se* was not the cause of the lesion, but rather that some low grade inflammatory process, influenced by the vascular pattern of the nutrient vessels, and abetted by physiologic trauma and strain, were more pertinent factors in the development of this lesion.

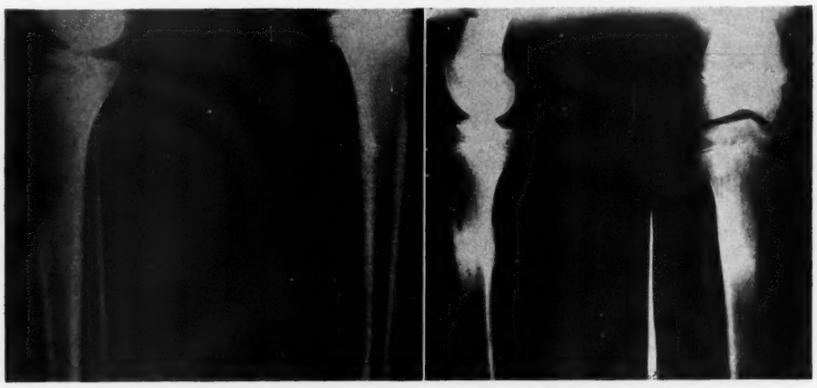
Weaver and Francisco,[2] in 1940, added three cases of their own to the twelve collected by Roberts and Vogt, making a total of fifteen cases reported. Their cases showed that the condition can occur in the older age group, thus widening the reported age incidence of from four to sixteen years to four to twenty-three years. It has also been demonstrated by the later authors that this very same lesion can occur in other bones. Specifically described were the upper and lower ends of the fibula of one individual. However, no matter which bones are involved the sites are comparable, being located at the junction of the infundibulum of the metaphysis and the diaphyseal shaft.

An allied condition is the "march fracture" which occurs in the shaft of the second or third metatarsal and is intimately associated with weak, relaxed feet and constant low grade trauma. Ollonqvist,[3] of Finland, reports a series of cases resembling pseudofracture of the tibia occurring in young army recruits. Weaver's cases would fall into this age group. In 1938, Looser[4] described a pathological condition of bone in which a rarefaction zone developed in or near the metaphysis followed by bone hyperplasia. From his description the term, "umbauzone," or "Looser's rarefaction zones," was coined. Two cases not presented in this article have been observed by the authors in which pseudofractures have developed in the upper tibia, of osteomyelitic bone following radical surgery of that bone. In both cases the absence of a normal marrow cavity and the poor bleeding quality of the bone evidenced the fact that the circulation was impaired.

The pathological report of four known biopsies showed varying degrees of a low grade inflammatory process consisting of perivascular mononuclear cell infiltration, fibrillar connective tissue displacement of the marrow and comparatively normal bone trabeculations.

The clinical importance of this disease entity is that the condition is often confused with a traumatic fracture, Ewing's sarcoma or osteomyelitis. The original authors dwelt at length on the differential diagnosis of traumatic fracture from pseudofracture because traumatic fracture was then the usual roentgenological report.

The pathological examination, however, invariably reported that the biopsy was of low grade inflammatory tissue. In the two cases presented the diagnosis was that of Ewing's sarcoma in the first, and osteomyelitis in the second, until further studies proved the cases to be pseudofractures. Irradiation therapy was being considered on one hand, and the Orr method of saucerization and open packing was considered as treatment for the other and would no doubt have been carried through just a few years ago.



A B

FIG. 1. A, showing area of lessened density and deposition of subperiosteal bone. B, localized sclerosis and subperiosteal deposits of bone producing the "peak phenomenon" on the medial and posterior surfaces.

A B

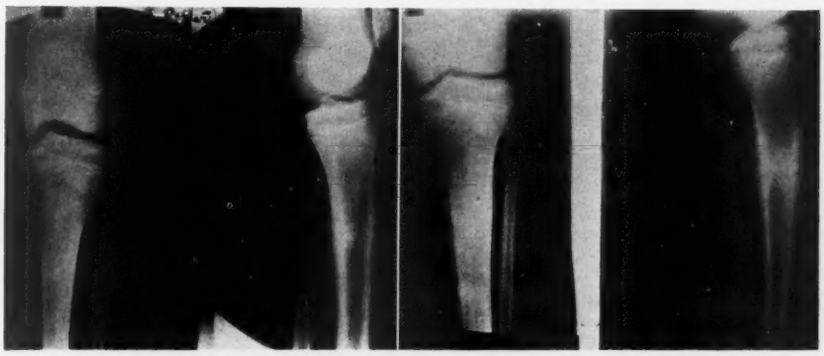
FIG. 2. A, development of pseudofracture line. B, the pseudofracture extends from the bone periphery through the callus.

In reviewing the clinical features we find that a history of slight injury to the area may or may not be present. At the onset there is usually a low grade fever accompanied by pain in the tibia about three inches below the tibial tubercle. The fever soon subsides and the patient is generally not so acutely ill as in osteomyelitis, or not ill at all. The pain is aggravated by use and relieved by rest, which fact differentiates the condition from bone tumor, in which the pain may be present at any time and even while at rest. The local examination shows that the pain area is precisely demarcated to a spot about three inches below the tibial tubercle. A small amount of localized edema and periosteal thickening can be made out, but usually the signs of abscess formation are lacking. Laboratory tests are not specific enough in their results to aid in the diagnosis. The diagnosis and differential are made mainly upon roentgenological studies. (Figs. 1, 2, and 3.)

X-RAY REPORT

The roentgenological studies show in the earliest cases a circumscribed area of lessened density at the junction of the upper and middle thirds of the tibia, central in location in reference to the diameter

of the shaft, and at a point three and one-half inches below the knee joint line. There is no soft tissue swelling and there is no



A B

FIG. 3. A, disappearance of pseudofracture line and smoothening out of the callus. B, the pseudofracture is disappearing and the sclerosis is being dissipated.

generalized osteoporosis. The rarefied area soon changes to one of localized sclerosis. The sclerosis is characteristic in that it is distributed transversely across the diameter of the shaft. It is about three-fourths of an inch wide, shows several short criss-crossed lines of rarefaction and the presence of new subperiosteal bone. The new bone is most prominent at the posterior aspect of the tibia, at which point it produces a definite "peak." There is only a very slight amount of new subperiosteal bone on the anterior surface. The medial surface also shows the increased periosteal bone with the "peak phenomenon" and a rather smooth deposition of bone on the lateral interosseous surface. As the condition heals, the subperiosteal deposits of new bone become distributed in a more uniform and fusiform manner, replacing the "peak phenomenon" seen earlier in the disease. The fact that most of the new bone is laid down on the posterior and medial surfaces would indicate that bone proliferation in this condition follows the line of greatest stress and strain to which the tibia is subjected. Subsequent pictures show that the area of sclerosis becomes narrowed down and a transverse, fracture-like line begins to make its appearance, developing at the periphery and approaching the center. This fracture-like line, which is the most characteristic feature of this condition, is a late progressive phenomenon, and it extends through the new subperiosteal bone as seen in different *x*-ray views. The line differs from a true traumatic fracture in that it develops as a progressive phenomenon, and it extends through the new bone deposits in contradistinction to a true fracture line, which stops at the callus.

Ewing's sarcoma in the earliest stages may give a similar picture because of the identical location and the laminated onion-peel deposits of subperiosteal bone. However, Codman's triangle as usually seen in malignant tumors is not characteristic in such conditions as pseudofracture of the tibia. The subperiosteal "peak phenomenon" and the presence of the pseudofracture line should clearly differentiate the two conditions.

CASE REPORTS

CASE 1. D. C., male, aged twelve years, developed sudden pain in the right upper leg. The pain was of a continuous character at the onset and moderate fever was present for one week. There was no history of injury, chills, sore throat or furunculosis. Weight loss or pains in other bones were not present. The pain became dull and low grade in character and was later present only on weight bearing and activity. Three months after onset the patient was admitted to the hospital, where an examination showed a well nourished boy not acutely ill.

The physical examination was negative except for the right leg.

The right leg showed a very slight palpable swelling on the inner aspect of the right tibia just three inches below the tibial tubercle. There was no local heat nor redness, no contracture of the ham-strings, no swelling nor edema of the lower leg, and the veins were not prominent. The painful zone was sharply circumscribed and pain was elicited on percussion and light pressure.

The laboratory work showed a normal blood sedimentation rate, a normal white and red count and normal differential. The urine and Wassermann tests were negative. The blood culture and agglutination tests for undulant fever and the typhoid group were negative.

The patient was immobilized in a plaster cast with immediate relief and made an uneventful recovery. Duration of the convalescence was six months.

Case II. E. P. The patient was an active, healthy girl of thirteen years who fell on the ice in February, sustaining only a slight abrasion of the shin. The patient continued her activity without any complaints until one month later, when she started to limp and complain of pain in the upper leg below the knee. There was no acute febrile attack at any time. The ache was recurrent on activity but never severe enough to confine her to bed. About four months after the original injury a "bump" the size of a quarter was noticed over the shin about three and one-half inches below the knee joint. The swelling and tenderness were fairly well circumscribed, but there was no redness or fluctuation. The patient was seen by several consultants who at first advanced the diagnosis of either Ewing's sarcoma or muscle stress fracture, until time brought out the true diagnosis. The ache and limp subsided with prolonged rest over a period of a six months convalescence. The "bump" on the shin still remains, but the *x*-ray picture shows complete healing with the disappearance of the fracture-like line.

SUMMARY AND CONCLUSION

The importance of this condition lies in the differential diagnosis rather than in the morbidity of the disease itself. Needless to say, traumatic fracture (because of its medicolegal aspect), Ewing's sarcoma and osteomyelitis are the main confusing entities that must be completely ruled out. All cases reported recovered with or without treatment. The treatment resolves itself into conservatism and rest of the part; and because one case has been reported by Roberts and Vogt in which a pathological fracture occurred during excessive use, a splint or a plaster cast for eight to twelve weeks and bed rest during the acute phase are recommended. The convalescent period for both cases was six months. A recurrence of pain was noted in Case I, following too early return to activity. Resumption of cast immobilization produced a clinical cure in six months.

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RECURRING PYOGENIC OSTEOMYELITIS

REPORT OF A CASE WITH A FORTY-SEVEN YEAR QUIESCENT PERIOD BETWEEN ATTACKS

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IT is generally understood that pyogenic osteomyelitis, after it has reached the chronic stage, may drain either continuously or intermittently for many years with relatively short periods of quiescence between exacerbations. That this disease might run through the acute to the chronic phases within a period of months and then lie dormant for years only to become active again is not well appreciated. The following case is of interest because it points out the potential danger of active recurrence of pyogenic osteomyelitis many decades after the subsidence of all clinical symptoms.

CASE REPORT

The patient is a white male, age fifty-six, a native of Latvia, Russia. At the age of nine years both feet and legs were frost bitten while sleigh riding. Both legs became infected, and about three months after the onset he was sent to a clinic where the legs were operated upon. The patient claims that "the bones (tibiae) were scraped." The wounds drained for approximately five or six months following operation and then healed.

He had no further trouble until the age of thirty when, while ice-skating, he fell and bruised the right tibia. The leg began to ache and swell, necessitating the application of moist hot packs. Three weeks after the injury drainage occurred spontaneously and lasted for two or three weeks. Since the age of thirty the right leg has ached occasionally unassociated with trauma. There have been times since the age of fifty when the soreness has been more pronounced. At such times poultices were used to localize the inflammation, evoking spontaneous evacuation of the pus which drained for a day or two.

The left leg was entirely symptom-free until December 2, 1939, forty-seven years after healing of the original focus in the tibia. On this date the left tibia sustained a sharp blow by a heavy ruler. Although the patient experienced immediate pain at the point of impact, he continued to work, the pain subsiding within an hour. Swelling and ecchymosis were noted at the site of trauma the same evening. On December 3, the leg began to ache. The pain increased gradually in intensity until sleep was interfered with. Moist hot packs afforded temporary relief.

Although he had lost thirty pounds due to lack of sleep since the onset of the present illness, his general health was good. The past history was essentially negative; he stated that, other than the trouble with his legs, he "never had a sick day in his life."

Physical examination on January 3, 1940, revealed the circumference of the left leg just above the malleoli to be 1 cm. more than the right. Three scars over the anteromesial aspect of the distal third of the left leg were noted. Increased local elevation of temperature was evident. This region was very tender, but no areas of fluctuation were palpable. The ankle motion was free. There were numerous large varicose veins of the entire leg. Left inguinal adenopathy was present.

There were several scars along the anteromesial aspect of the right leg at the middle and lower thirds. Palpation did not reveal any tender areas or increased local heat. Large varicose veins were noted.

The laboratory data showed a sedimentation rate of 31 mm. the first hour. The red count was normal. The total leucocyte count was 14,550 with 48 per cent adult and 4 per cent band polymorphonuclears. The Kahn reaction was negative.

Roentgenographic examination of both legs was made on December 22, 1939, and repeated on January 17, 1940. The anteroposterior view of the left tibia revealed a club-like thickening of the distal half. (Fig. 1.) The cortex in this

region was thickened and very irregular. About one and one-half inches from the distal articulation a well demarcated shadow representing

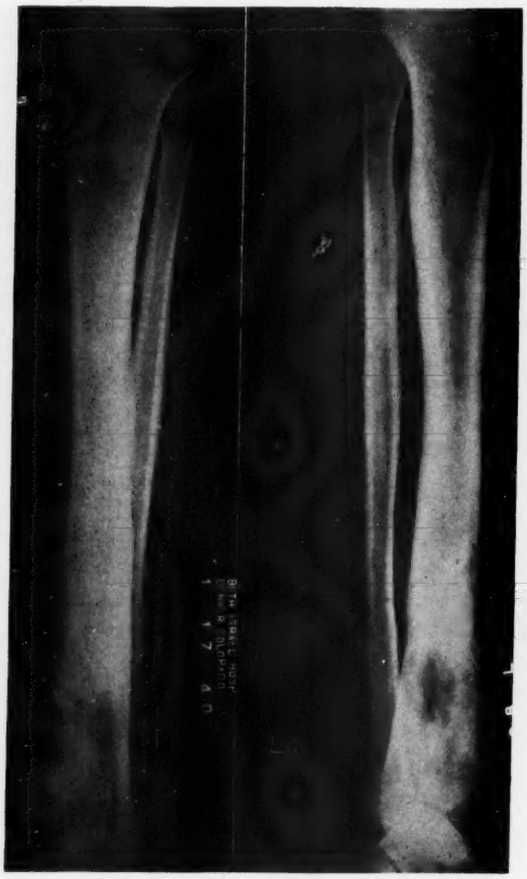

FIG. 1. Anteroposterior and lateral views of the left tibia showing the abscess cavity and the thickening of the distal half.

an abscess cavity was seen. The bone surrounding the cavity appeared very dense. The abscess was even more plainly visible on the lateral view. (Fig. 1.) The rarefied area measured one and one-half by one and one-fourth inches. The cortex in this region seemed intact. The medullary canal was almost obliterated in the distal half. The ankle joint was clear.

The anteroposterior view of the right tibia revealed a similar club-like appearance of the distal half. (Fig. 2.) The cortex in this region was likewise thickened and irregular. Although a suggestive mottling was seen, especially in the lateral view (Fig. 2.), there was no definite abscess cavity. The ankle joint was negative.

A diagnosis of reactivation of an old, quiescent, osteomyelitic focus of the left tibia was made. Conservative treatment was carried out at home for ten days without alleviation of the symptoms, during which time a slight fever was recorded. Operative interference was then advised, and the patient was hospitalized.

FIG. 2. Anteroposterior and lateral views of the right tibia. Note the increase in width of the distal half with obliteration of the medullary canal.

On January 18, 1940, under ether anesthesia the left tibia was exposed. A small hole was found in the cortex through which pus welled out as though it were under increased pressure. A culture was taken. A window was made in the cortex, revealing an abscess cavity approximately two and one-half inches in length, the walls of which were very thick and eburnated. The cavity itself was filled with light greenish-yellow, thick, gelatinous pus. The lateral wall of the cavity was eroded entirely through the tibia. The abscess was completely unroofed and packed with vaseline gauze. A plaster cast from midthigh to the toes was applied.

A direct smear of the pus taken at operation showed two small clumps of Gram-positive cocci. The twenty-four-hour culture revealed no growth. After forty-eight hours a pure culture of Staphylococcus albus was obtained. Repeated cultures verified this result.

COMMENT

The findings in this case indicate that the osteomyelitic focus in the left tibia was a sequella of the original inflammation forty-seven years previous to the present attack. The marked eburnation of the abscess wall, the gelatine-like quality of the pus, the sparcity of organisms on direct smear and their attenuation, requiring forty-eight hours for growth on appropriate culture media, would seem to verify this opinion.

Phemister[1] believes that foci of osteomyelitis may be silent not only in the development of the lesion but also to the stage of complete bony destruction before any local symptoms become manifest. If the lesion is a recurrence in a previous site of osteomyelitis, general symptoms of infection may be present even though the local lesion is silent. He explains the silence of the lesion as being due in part to the low grade of the inflammatory process which may be the result of attenuation of microorganisms or of an increase in body resistance in the course of prolonged infection. The reported case shows that osteomyelitic foci can and do remain silent over a period of a lifetime, awaiting only proper stimuli and conditions of the host to reawaken into clinical activity.

Breck[2] recorded a case of chronic osteomyelitis in which there was an interval of fifty years between operations. This patient had recurring mild attacks of pain and swelling which lasted for several days throughout the entire intervening period. There was no mention of drainage associated with the attacks. The author's case differs from Breck's in that there were no symptoms referable to the left leg during the forty-seven years.

Although the factor of trauma is problematical at best in certain cases of pyogenic osteomyelitis, there is little doubt that the realighting of the disease in this instance was directly attributable to the blow struck by the ruler. The cause and effect appear to be intimately related.

SUMMARY

A case of pyogenic osteomyelitis of the left tibia, erupting after a forty-seven-year interval of quiescence, is presented. It illustrates that this disease may be an ever-present sword of Damocles to a patient, and that an apparently well healed lesion may become active under proper conditions.

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ADENOMA OF LANGERHANS' ISLET OF THE PANCREAS*

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REPORT OF CASE

M. H. H., age sixty, had had periods of mental confusion, difficulty in walking and loss of stature. The patient had been under treatment in another city for chronic arthritis. Vaccines and diathermy had been administered during the last three years, in spite of which walking had become more and more difficult. The patient's family had noticed that she was not as tall as she used to be.

In September 1939, while talking with a friend on the telephone, she became incoherent, her voice weakened and ceased altogether. Two hours later, her son found her with the telephone receiver in her hand and in a stuporous condition. A cup of hot tea was given, after which she recovered quickly. She remembered a sense of weakness coming over her while she was phoning. A month later a similar attack occurred during which she laughed and cried alternately, perspired freely and made uncoordinated movements of the arms and legs. Hot tea was again given and she recovered promptly. Recurrences appeared about every two weeks and lasted one or two hours, except when hot drinks terminated them abruptly. The patient thought she could anticipate an episode by a burning sensation in the tip of the tongue on several occasions. Vertigo had become frequent since the first attack, but no visual disturbance or headache were noted.

She was admitted to the hospital for diagnosis. Her head was of normal size and shape; the nose, throat and ear examinations were negative. The thyroid showed no enlargement or adenoma. Heart and lungs were normal. Her abdomen was obese with low midline scar (previous tubal pregnancy). The Liver and spleen were not palpated. No masses, tenderness or muscle spasm could be made out. Vaginal and rectal examinations were negative. A marked lordosis of the lumbar spine was present, as well as marked bowing of the femurs, which caused the patient to cross her legs scissor-fashion while lying in bed. Reflexes were normal except for the pupils which reacted sluggishly to light. Visual fields were normal, eye grounds normal.

X-ray examination of the skull showed normal sella and changes of osteitis deformans. Pelvis and femurs showed osteitis. Laboratory findings were as follows: Blood-hemoglobin 90 per cent, red blood count 4,540,000, color-index .9, leucocytes 9,200. Differential: segmented 51, rod. nuclei 4, lymphocytes 45. Wassermann: plain antigen negative, cholesterinized 2 plus, Kahn 1 plus. Spinal fluid: negative including Wassermann and Kahn. Chemistry: nonprotein nitrogen 30, calcium 10.7, phosphorus, 7.8, fasting blood sugar 66; glucose tolerance (after ingesting 100 Gm.) fasting 31 mg. one-half hour 176, 1 hour 152, 2 hours 111, 3 hours 107, 4 hours 50. Blood sugar response to adrenalin (1:1000) 1 cc., fasting 60 mg. 1 hour after 72 mg. Blood sugar response to insulin 10 units; fasting 54, 1 hour 58, 2 hours 54.

Episodes of noisy confusion and disorientation accompanied at times by muscle twitching occurred several times daily. Between 5 and 7 A.M. one would appear daily, and frequently before lunch and dinner as well. They were quickly relieved by sugar or orange juice, and were followed by retrograde amnesia. Withholding food would bring one on in three or four hours. An aura of a burning sensation in the tip of the tongue sometimes preceded the attack by an hour or more. On a high carbohydrate diet with three-hour feedings, the attacks did not recur, so the patient was allowed to return home for a trial period of six weeks.

Diagnosis: Hyperinsulinism and osteitis deformans.

Second Admission. On the fifteenth day after discharge, the patient fell and fractured her left femur. For the first ten days after leaving the hospital no hypoglycemic attacks occurred, but they then began to reappear and became more and more frequent. It was necessary to take some food every three hours during the night as well as day. The examination was unchanged except for a transverse fracture of the left femur.

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In the hospital on a high carbohydrate diet with three-hour feedings, no hypoglycemic episodes appeared from date of admission to April 23, 1940 when an open reduction of the femur was done. Her postoperative chart was uneventful except for symptoms of weakness and diaphoresis. However, during the third week and in spite of the frequent feedings of carbohydrate, symptoms of hypoglycemia recurred more frequently. At least three or four appeared each day but were relieved by sugar.

Laboratory findings were repeated and unchanged. Glucose tolerance showed fasting 33, one-half hour 140, 1 hour 129, 2 hours 117, 3 hours 111, 4 hours 50 mg. A diagnosis of hyperinsulinism probably due to islet tumor was made, and it was decided to explore the pancreas.

Through a wide transverse incision about 2½ inches above the umbilicus, the abdomen was opened. The liver, spleen, stomach and intestines appeared normal and the lesser sac was entered through the greater omentum. The stomach was turned up and the pancreas exposed. A tumor the size and color of a small plum was found on the superior surface of the gland at the junction of the body and tail. It was soft, friable and encapsulated, lying in a bed of normal appearing pancreas with several blood vessels running into it. It was enucleated easily and the blood vessels ligated with fine chromic catgut. The remainder of the gland appeared normal. A small tissue drain was placed in the bed, and the omentum closed around it. The abdomen was closed with zero chromic catgut in all layers.

Pathological report was encapsulated tumor 4 by 4½ by 2 cm. The tumor is of soft consistency. The cut surface is homogenous and of grayish pink color. (Fig. 1.)

Histologically a fairly uniform character could be observed. The tumor is composed of round or cubical cells with a faintly acidophilic cytoplasm and a round nucleus showing a fine chromatin structure and a small nucleolus. These cells form small trabeculae or solid nests. (Fig. 2.) Smaller or larger areas of these cell complexes are separated by a fine meshwork of connective tissue stroma dividing them into island-like areas. These areas are very similar to Langerhans' islets, except that they are somewhat larger. The similarity is even more pronounced in some places where the connective tissue stroma is augmented. Here the appearance is definitely that of accumulated Langerhans' islets. (Fig. 3.) The tumor is characterized throughout by its wealth of

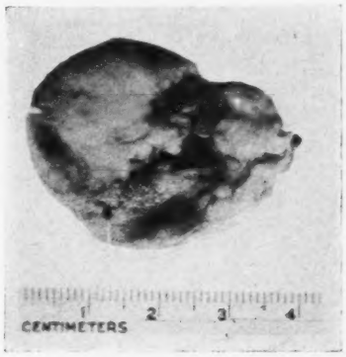

Fig. 1. Gross appearance of the adenoma.

capillaries, which are not only present in the stroma but appear between the parenchyma cell trabeculae.

Diagnosis: Langerhans' island adenoma of the pancreas.

No further symptoms of hypoglycemia appeared after operation. A glucose tolerance test done a few days after showed a mildly diabetic curve, and on one occasion there was a sugar spill-over in the urine after intravenous glucose was given. The patient ran a low grade temperature and after a few days began to complain of left upper quadrant pain which was aggravated by eating or drinking. There was a moderate amount of serous drainage, and several areas of induration appeared in the subcutaneous fat of the abdominal wall. The leucocyte count increased to 17,000, and the temperature rose gradually. The left upper quadrant pain became referred to the shoulder and back. *X*-ray of the diaphragm was negative. About three weeks after the operation, it was decided to reopen the left half of the incision because of the localization of pain and tenderness in that area.

At re-operation the sinus from the tissue drain was followed down to a pocket of necrotic fat and pus in the omentum. The pancreas could be felt beneath the omentum, as a hard fixed organ. Bloody serum appeared from the left subdiaphragmatic space and lateral gutter. Tissue drains were inserted in the subdiaphragmatic space and in the abscess of the omentum. The wound was closed with through-and-through silk sutures.

Ten units of protomine zinc insulin daily were given for a few days and the temperature

returned to normal. The pain and tenderness gradually disappeared and the patient made an uneventful recovery.

because they were relieved after ingestion of sugar in some form and they never reappeared after the adenoma was removed.

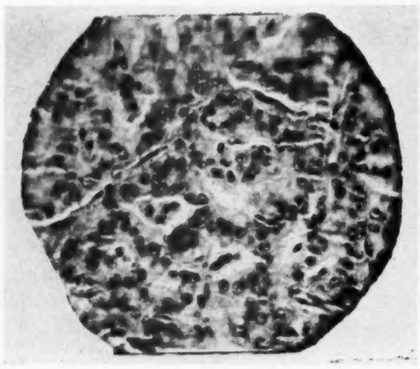

FIG. 2.

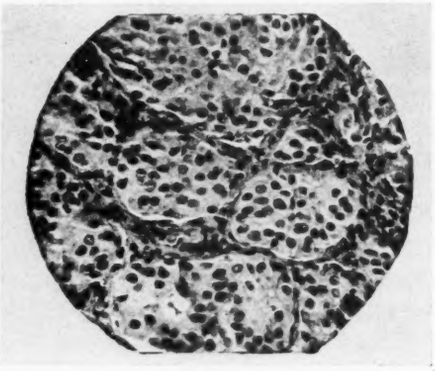

FIG. 3.

FIG. 2. Section showing cells arranged in island-like formation. × 277.
FIG. 3. Section showing area simulating accumulated Langerhans' islets. × 277.

DISCUSSION

The case presented did not cause difficulties in diagnosis after the clinical symptoms were correlated with the laboratory findings. Hypoglycemic conditions caused by disease of other organs than the pancreatic islands (hypothyroidism, hypopituitarism, hypoadrenalism and liver disease) could be eliminated by lack of signs and symptoms pointing to these organs. The differentiation from functional hypoglycemia was done on the basis of: (1) The severity and constancy of the symptoms; (2) the abnormally low fasting blood sugar level and the behavior of the glucose tolerance test, and (3) no permanent results were obtained by dietary measures (high carbohydrate diet, frequent feedings).

There were two interesting features worth mentioning. One was that the hypoglycemia manifested itself mostly in mental confusion, the other was the behavior of the glucose tolerance test.

The symptoms consisted mostly of irrationality, laughing and swearing without reason and retrograde amnesia accompanied by sweating and trembling of the extremities. That these symptoms were really due to hypoglycemia was proved

The glucose tolerance with a subnormal initial value and with a peak not reaching above normal, then dropping down to subnormal again, is too much stressed in textbooks discussing this disease. The tolerance test which presented itself in our case showed a subnormal initial value but the peak reached high above the normal levels, stayed there for one hour and then dropped again to subnormal values. The type which the glucose tolerance will present depends on the individual underlying pathological conditions. The important feature will be the subnormal initial value and the drop to subnormal again within four hours.

SUMMARY

A case report of an adenoma of Langerhans' islet of the pancreas is presented. The symptoms were marked by episodes of mental confusion and irrationality followed by retrograde amnesia.

The glucose tolerance curves were characterized by low initial values with a peak high above normal levels remaining for an hour and dropping again to subnormal values.

The postoperative course was complicated by pancreatitis and a slow recovery.

DIAGNOSTIC POINTS IN INTRA-ABDOMINAL PREGNANCY

REPORT OF A CASE

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INTRA-ABDOMINAL pregnancy, exclusive of tubal pregnancy, though uncommon, is not a rarity. The purpose of this article is to point out the salient points in order to assist others, especially the general practitioner, to keep in mind the possibility of intra-abdominal pregnancy.

Two cases of combined intra-abdominal and intra-uterine pregnancy are referred to in the report by Hellmann and Simon.[3] An occasional case of intra-abdominal pregnancy despite a previous hysterectomy has been reported. Likewise, intra-abdominal pregnancy may follow as the result of rupture of the uterine scar after a previous classical cesarean section. Abdominal pregnancy usually is secondary to tubal pregnancy following either tubal abortion or rupture.

The reported instances of intra-abdominal pregnancy show a marked variation. Swanson states that it occurred in one out of 2,300 births in the series which he reviewed, Kiefer one in 4,400 cases, whereas Harnes, reviewing the files of the New York Lying-In Hospital, found one in 15,600. The mortality has been high in the Lying-In Hospital group, as much as 40 per cent. Beck, after reviewing the literature from 1809 to 1919, arrived at a figure of 35.6 per cent mortality in 257 cases. Hellman and Simon in a study of 316 collected cases, stated that the fetus in 158 patients lived eight days or more. The mother and child lived in only eighty of these cases. Of the total 316 mothers, 101 died, the outcome of three being unknown.

SYMPTOMATOLOGY

Since most intra-abdominal pregnancies are secondary to previous ectopic pregnancy, the early symptoms would be those of tubal pregnancy. They may, however, be so mild that the patient may not consider it necessary to consult her physician, or if the latter be called in, the patient not feeling acutely ill, might not accede to his advice to undergo an immediate laparotomy. From then on, the patient might go on to term without any exceptional symptoms and the unusual type of pregnancy be unsuspected until normal labor fails to set in. More commonly, however, because of the close proximity of the fetus to the abdominal wall and to various abdominal viscerae, movements of the fetus cause intense pain and the abdominal wall is unusually tender. At times so sensitive is the abdominal wall that the pressure of clothing is unbearable. This was borne out in the case being reported, pain on walking being so marked at times, that relief was obtained only by lying motionless in bed. Fetal parts are felt with unusual ease. Nausea and vomiting frequently are present throughout the latter months. Coupled with excessive nausea and vomiting and the extraordinary and troublesome generalized abdominal, gaseous distention, also a common finding, marked localized tenderness and a sense of rigidity in the right upper quadrant may lead one to believe that the gallbladder is pathologically involved. Such was the case in the patient whose history is later reported, the localized tenderness, mass and sense of rigidity in this instance being due to the head of the fetus which was in close contact with the right upper quadrant of the abdominal wall. The excessive pain resulting from fetal movements may be brought about by the stretching of adhesions that have formed between the fetal sac and the abdominal

viscerae. It was surprising that no mention in the literature was made of intestinal obstruction caused by such adhesions.

When pregnancy persists beyond the expected date of confinement, the possibility of intra-abdominal pregnancy should be considered if its presence has hitherto been unsuspected. A valuable clinical point in diagnosis was stressed by Nathan Adler[9] who pointed out that percussion of the abdomen in a normal intra-uterine pregnancy usually reveals tympany in the flanks and dullness over the middle area. In intra-abdominal pregnancy the fetus is usually almost wholly to one side of the spinal column and interestingly enough, occupies the right half of the abdominal cavity in most instances. Dullness, therefore, is elicited over that half of the abdomen in which the fetus is situated, with marked tympany being present over the middle and the other half of the abdominal cavity as a result of the intestines being crowded by the fetus toward these areas.

Fig. 1. Plain plate of the abdomen revealing fetus completely to the right of the spine of the mother.

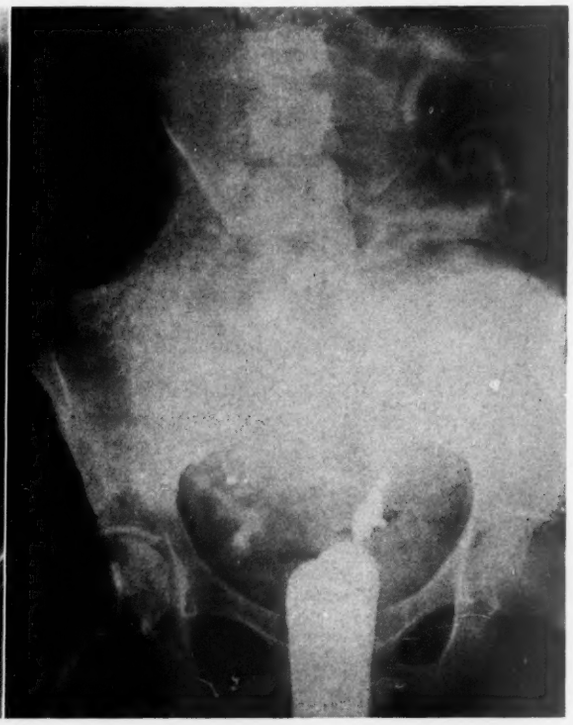

Fig. 2. Lipiodol injection demonstrates a small uterus and clearly demonstrates intra-abdominal position of the fetus.

An interesting finding is the passage of blood per rectum. In the case reported herein, the patient had suffered from a fissure-in-ano, which had received treatment sometime previous to her becoming pregnant. There was very little bleeding from this fissure during her pregnancy. There are times, however, when bleeding per rectum in a case of intra-abdominal pregnancy may be quite marked and no pathological condition in the rectum *per se* be found to explain bleeding. Bleeding may follow erosion of the intestinal wall by chorionic villi or as the result of a perforation of the bowel by loose bony fragments following maceration of the fetus. Although the placenta in the case under discussion was implanted upon the sigmoid colon, no erosion due to the chorionic villi took place.

Constipation and diarrhea may be present but are of no differential assistance in diagnosing an intra-abdominal pregnancy.

The fetus may live to term, although this is not usual. As in our case, the fetus may expire, no fetal heart be heard, but the mother continue to feel movements. An explanation of this phenomenon perhaps

may be as follows: Due to the adhesions of the fetal sac to the intestines, peristalsis of the latter may give rise to "pulling" pain. The pregnant woman is conditioned psychically to expect pain with fetal movements in the latter months of pregnancy and consequently interprets the "pulling" pain as the result of fetal movements. Despite the physician's inability to hear the fetal heart, the patient will insist that she feels fetal movements.

When confronted with an intra-uterine pregnancy, wherein a fetal heart has been heard consistently and then is no longer heard, the statements of the patient that she feels vigorous movements lends a false sense of security to her physician. He reasons that the baby is still alive and presumes that the fetus probably has assumed a posterior position. When fetal parts, however, are palpable as easily as they are in intra-abdominal pregnancy, failure to hear the fetal heart despite the patient's assurance that she feels movements should lead one to suspect the presence of intra-abdominal pregnancy.

False labor usually occurs whether the fetus dies in the latter months or lives to full term. Even before the onset of such false labor, two valuable procedures, in addition to the physical findings of tympany in percussion over the middle of the abdomen, assist in establishing a diagnosis of intra-abdominal pregnancy. *X*-ray examination will reveal the presence of a fetus lying almost entirely to one side of the spine, usually to the right. Upon pelvic examination it may be possible to outline the uterus as a mass practically normal or somewhat larger than normal and distinct from the larger abdominal mass which is the fetus. If necessary and without any fear of unpleasant complications, an intra-uterine sound may be introduced. This may be done without a general anesthetic. The introduction of lipiodol through such a sound in the uterus, followed by *x*-ray exposure will demonstrate conclusively as in the accompanying illustrations, the presence of a nonpregnant uterus with the sound usually pointing in a direction away from the fetus.

AFTER DIAGNOSIS IS ESTABLISHED

Once the diagnosis of intra-abdominal pregnancy has been established, there seems to be no uniformity of opinion on the subject of immediate operation. Some have advised immediate operation; others have suggested waiting until the fetus is viable; still others urge waiting for the death of the fetus so that placental separation may begin.

Although there is a likelihood of minor or major deformity due to mechanical causes resulting from pressure by abdominal viscerae, normal infants have been delivered more frequently than some authors seem to believe.[1] It would seem advisable, therefore, to disregard the suggestion of those who urge operation as soon as the diagnosis of intra-abdominal pregnancy has been established and to wait preferably until the viability of the child has been reasonably assured.

The advice to await the death of the fetus so that separation of the placenta will have begun is unwise and would lead to unnecessary loss of infants. Such delay infers waiting until maceration has taken place. This adds to the danger of sepsis inasmuch as loose fragments of bone may perforate the intestines. Indeed, Halliban, quoted by Swanson,[1] reported a case in which bony parts were expelled per rectum some thirty years after a nondiagnosed intra-abdominal pregnancy. In that case it is quite probable that the fetus failed to attain a size large enough to lead to clinical suspicions of the correct diagnosis.

OPERATIVE TECHNIC

If the fetal sac is not ruptured, it should be opened in an avascular area. The patient should be first typed and cross-matched for immediate blood transfusion should it become advisable. After the fetus has been removed, no effort should be made to separate the fetal sac from any of the loops of intestine or other abdominal viscerae to

which it may be attached, unless this can be done with ease and without damage to the abdominal organs. If the placenta is implanted on pelvic structures, except the pelvic vessels, removal may be possible, especially if a pedicle is present. Interrupted sutures, tied not too tightly, should be utilized in ligating the placental pedicles attached either to the ovary or tube.

It has been suggested by Cornell and Lash[5] that it is safer to marsupialize and pack in such instances of intra-abdominal pregnancy in which the placenta is attached to an abdominal viscus, as for instance, the intestines, the mesentery or liver. This, however, is unnecessary. Beck's experimental work with dogs[5] and the teaching of Falk[6] as well as the author's personal experience in the case herein reported, definitely point to the advisability of tying and cutting the cord close to the placenta, leaving the latter *in situ* and closing the abdomen without drainage. Although quite a long time may elapse before complete absorption of the placenta takes place, this ultimately does occur. In the case herein reported, the fetal sac was adherent in several areas to loops of bowel and contained in its wall good-sized veins. No effort was made to free the sac except where adhesions could be separated without any possible damage to the bowel. A secondary abscess later developed, necessitating an incision and drainage of the wound, resulting most likely from the macerated sac which had been left *in situ*. Abdominal exploration fifteen months later for the relief of pain due to adhesions failed to reveal any suggestion of either fetal sac or placenta. The uterus, left adnexae and sigmoid colon, the site of the placental attachment, were found to be completely normal.

CASE REPORT

Mrs. R. C., age twenty-five, gave a history which was irrelevant and essentially negative, except for regular menstruation lasting eight days with clots about the size of a quarter.

The patient was seen first on September 17, 1936. Menses were due on August 18, 1936 and appeared September 3, 1936. Clots were passed the first two days; staining persisted until the day of examination. Nausea and vomiting were present. Pelvic examination was negative on September 22, 1936; staining was present for a period of nineteen days. Her breasts were slightly tender. An Aschheim-Zondek test was advised because of the inability to feel any possible tubal pregnancy and the presence of prominent Montgomery follicles and slightly tender breasts. The report was positive.

When seen next on October 3, 1936, staining had stopped. A mass, interpreted as a uterus enlarged to the size of a five to six weeks' pregnancy, was palpable. A diagnosis of a normal intra-uterine pregnancy was made and an estimated date of confinement was set at about April 24, 1937. During the next three months, vomiting became troublesome but responded satisfactorily to the administration of luetin injections. What was interpreted as the intra-uterine pregnancy increased in size at apparently a normal rate. Blood pressure and urinalysis remained normal throughout. On December 29, 1936 the patient stated she felt life. On January 18, 1937 the abdominal mass measured 20 cm. and although patient stated she felt life, a fetal heart was not heard. Pelvic examination elicited small parts below, which seemed to move during the examination. The patient stated she was not certain whether she felt fetal movement. *X*-ray examination was advised.

X-ray examination done January 19, 1937 by Dr. Louis Nathanson was reported as follows: "There is evidence of a single pregnancy entirely within the pelvis. The uterus rises to the level of the upper portion of the sacrum. The head is situated to the right of the midline and overlies the sacroiliac region. Small parts are in the true pelvis. Due to marked overlapping of the parts, one cannot definitely outline spine nor can one differentiate many of the small parts. However, when studied in the lateral view, the outline of the skull is well visualized and much of the facial structures can be demonstrated. The head and facial structures from this view do not appear to be normal. I do not believe from the roentgenogram, that we are justified in concluding that the fetus is abnormal."

Five days later, on January 26, 1937, a fetal heart was heard distinctly in the right lower

quadrant, rate 144. On February 8 and February 9, 1937, the fetal heart was not heard, but movements were felt by the patient. On March 8, 1937, a fetal heart was again heard in right lower quadrant and was heard again on March 22, 1937, April 5, 1937 and April 12, 1937. On April 13, 1937, contraction pains appeared. Rectal examination revealed an apparent one-finger dilatation and diagnosis of breech with buttocks presentation was made. *X*-ray examination by Dr. Louis Nathanson was reported as follows: "Evidence of a single pregnancy breech presentation with almost the entire fetus on the right side. Head is in the right upper quadrant. The skeletal structures of the fetus are well developed."

The patient was admitted to the Madison Park Hospital, but discharged the following day with diagnosis of false labor. Considerable pain over the next two days was felt in the right upper quadrant of the abdomen with marked tenderness present. In the light of subsequent findings, the normal temperature and the lack of vomiting, what was thought to be a possible cholecystitis was probably the disturbance in the right upper quadrant, brought about by the movement of the fetal parts.

From April 15, 1937 to April 26, 1937, occasional vomiting was present. On April 26, 1937, the fetal heart seemed distant and on May 3, 1937 it was impossible to state definitely that the fetal heart was heard. Movements were no longer definitely discernible to the patient and on May 10, 1937 the movements were practically no longer felt and the fetal heart was not heard. On May 20, 1937, dark, bloody vaginal staining was present. No fetal heart was heard. The patient was not toxic and failed to respond to castor oil in an effort to induce delivery. *X*-ray examination revealed overlapping of the skull bones, a breech. Pelvic examination gave the impression of the fetus being extra-uterine.

On consultation by Dr. Adler, he corroborated this impression. On May 23, 1937 lipiodol study and sounding of the uterus revealed a uterus about the size of three months with the intra-uterine sound turning to the left side. On May 24, 1937, Dr. Thurston Welton, called in consultation, likewise agreed with the diagnosis of abdominal pregnancy and on that day, through a suprapubic midline incision, an operation to remove the fetus was done. A macerated fetus about seven months in size was found in a sac occupying the right side of the abdomen. The sac was adherent to loops of the bowel. Friable adhesions were easily separated. The placenta was found attached to the sigmoid colon and enveloped the left tube. The left tube was easily freed. The uterus was enlarged to about a three months' pregnancy. The fetus was delivered as a breech. An effort to remove the placenta led to bleeding. It was then determined to leave the placenta *in situ*, recalling that Beck's work with dogs demonstrated conclusively that the body can well take care of the situation and complete absorption of the placental tissues occurs. Iodoform packing was placed against the bleeding placental site. On the fifth day, postoperatively, the packing was removed under 4 cc. of intravenous evipal anesthesia and on June 10, 1937, the patient was discharged from the hospital with the wound healed and in good condition.

Nine days later a temperature of 100.6° (r) appeared. No definite evidence of wound infection nor of abdominal collection was found. On June 29, 1937, a sedimentation test revealed a rate of 100 in one hour, compared to a normal of 20. Pelvic examination revealed a mass in the left lower quadrant which was thought to be the placenta. Sedimentation test repeated on July 13 and July 20 were still 100 in an hour. On August 9, 1937, the temperature was 101.6° (o) with considerable suprapubic pain and the presence of a tender mass was noted. Local applications and Trendelenburg position were prescribed. On August 14, 1937, adequate softening being present, the mass was opened under local novocaine infiltration and a large amount of thin, light, greenish-yellow pus was evacuated. The possibility of this being from an intraperitoneal site instead of being limited to a wound infection was kept in mind. Drainage continued with the temperature ranging between 99 to 100° (o) until September 11, 1937, when the patient felt quite well. On September 13, 1937 a small pocket at the upper end of the wound was opened under local novocaine and a slight amount of discharge evacuated. On September 17, 1937 menses appeared, small clots being present. On October 23, 1937 lipiodol injection into the fistulous tract and *x*-ray examination were done in an effort to determine whether the discharge that still persisted, though slight,

was coming from the side of the placental attachment, or from a broken down sac which had been left in the abdomen. A blood chemistry on October 23, 1937 was reported as follows: glucose 96 mg./100 cc. blood; urea N. 17.6 mg./100 cc. blood; cholesterol 160 mg./100 cc. blood. Sedimentation curve showed a slight to moderately active reaction. Culture of pus from the sinus revealed a Staphylococcic albus. A blood Wassermann test was negative. Menses reappeared six weeks later. Foreign protein injections were administered. The drainage from the sinus gradually diminished, probably an after-effect of the injection of lipiodol. On November 14, 1937, it was impossible to visualize any lipiodol in the abdomen. Temperature became normal on December 2, 1937. Drainage was scanty and by January 15, 1938 the wound was perfectly healed. Sedimentation rate was normal and on pelvic examination the uterus was felt to be in good position, slightly subinvoluted and the adnexal regions were normal except for slight tenderness at the left fornix, no mass being palpable. Special care was taken to note whether it was possible to feel the retained placenta.

During the months from February to July 1938, the patient felt well, except for a persistent "pulling pain" in the region of the wound, especially noted when standing up from a sitting position. It was suggested to her that the cause of this pain might be due to postoperative adhesions to the wound and that liberation of these adhesions might bring about relief. On August 2, 1938, the patient was readmitted to the Madison Park Hospital and under open ether anesthesia the lower half of the scar was excised. There was evidence of old necrotic tissue in an area about 1 cm. in diameter through which the former sinus opened. This, however, was not connected with the abdominal cavity. There were adhesions of the omentum to the scar and a loop of the small intestine was attached to the abdominal aspect of the wound. The uterus was in good position and appeared normal. The right tube and ovary and left tube were normal. The left ovary was cystic and slightly enlarged. The descending colon and sigmoid were perfectly normal. No evidence of any fistulous tract was present nor were there any signs whatsoever of amniotic sac nor of the placenta which had been left *in situ*. The adhesions were separated after double ligation and the loop of the small bowel was freed. The abdomen was closed without drainage. Twelve days later the patient was discharged in good condition.

Progress of the case has been normal and when last examined on June 29, 1940, no evidence of pelvic abnormality was elicited. A tubal insufflation test, done because of the patient's inability to become pregnant, revealed patent tubes.

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MOBILE CECUM WITH LEFT HYDROCELE*

CASE REPORT

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ACCORDING to W. R. Houston, about 20 per cent of persons have a mobile cecum as the result of a fault in embryonic development. This is usually due to an absence of fixation of the ascending colon to the posterior abdominal wall. Failure of rotation of the cecum may result in a wide range of variation in its position. From the autopsies performed on infants at the New York Foundling Hospital, the cecum was found on the left side of the abdomen in five cases, two in the male and three in the female. From an *x*-ray viewpoint the cecum is often seen to be mobile, so that it is only when fixation of the cecum takes place in an abnormal position that it can be considered of significance.

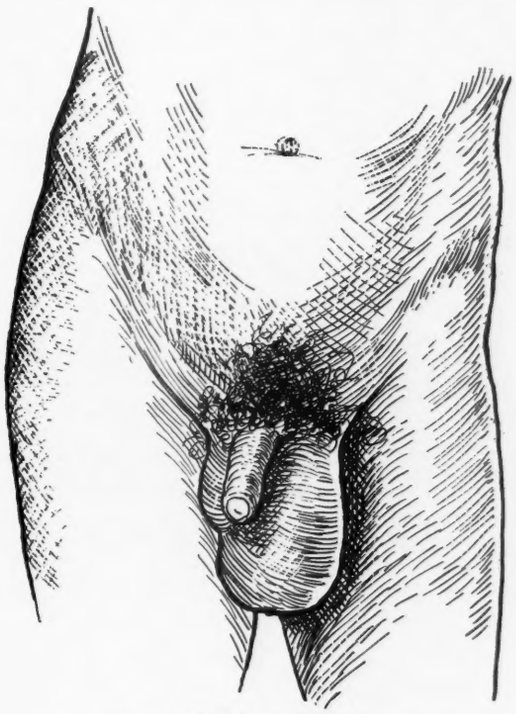

FIG. 1. Showing scrotal mass.

CASE REPORT

W. M., No. 62495, age fifty-five, was admitted to the University Hospital with the complaint of swelling in the left side of the abdomen with a history of a gradual increasing enlargement of the left scrotum over a period of four to five years, the condition being practically painless. The history as to trauma or infection of the urinary tract was negative. The physical examination was essentially negative except for a large mass in the left scrotum. This mass was about the size of the doubled fist; the skin was tense but there was no external indication of inflammation. The lowermost portion trans-illuminated light but the upper portion

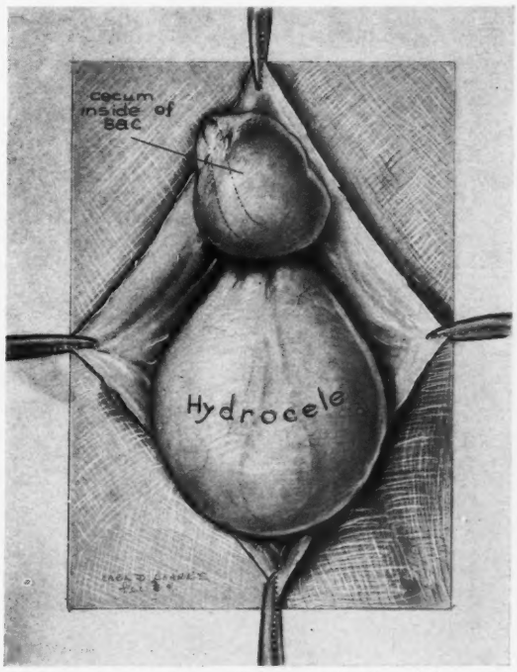

FIG. 2. Showing the relation of the hernial sac to the hydrocele.

* From the Urological Department, University of Maryland.

was opaque. A diagnosis of left hydrocele and left scrotal hernia was made. A barium enema showed the cecum in the right lower quadrant but somewhat irregular. At operation a large hernial sac was first uncovered. Upon opening the sac the appendix immediately appeared. The entire cecum was loose and easily replaced in the abdomen. An appendectomy was performed and the hernial sac closed off, after which a herniotomy was done. The hydrocele sac which contained about 250 cc. of clear, straw-colored hydrocele fluid was excised. The patient recovered without complications.

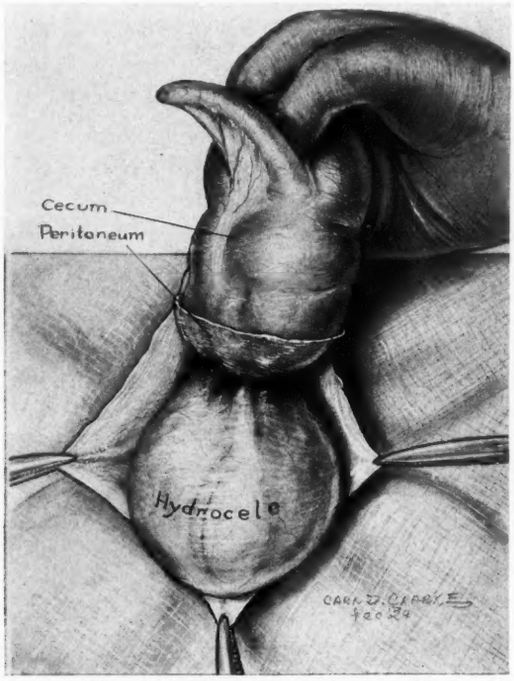

FIG. 3. Showing the cecum and appendix in the hernial sac.

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New Instruments

DOG SURGERY

DESCRIPTIONS OF TECHNIC FOR ANESTHESIA AND OF A RESPIRATOR FOR THORACIC SURGERY PRACTICE

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IN a recent editorial in the *American Journal of Surgery* it was suggested that the small town surgeon can practice surgical technic by operations performed on dogs. Comment was made upon some of the surgical procedures which lend themselves to this form of self-development.

Facility acquired in the handling of instruments, suture materials and tissues has been a valuable reward for the time given to this work. Operations done infrequently in general surgical practice become routine procedures to one who employs this means for developing technic. New operations are given trial and pitfalls may often be recognized before the human patient is exposed to them. Thus, dog surgery is a method for improving skill which can be of service to both the beginner and the accomplished surgeon. It can be made available anywhere at a cost which is negligible.

We wish to outline our routine preparation of the animal for surgery and to describe a homemade apparatus which makes possible open thoracic surgery without the aid of an assistant.

We have an arrangement with a man whose home is sufficiently isolated to prevent public observation and comment. He obtains the dog from the pound in another city and when, at the appointed time, we arrive at his home the dog is anesthetized, shaved, and in position on a homemade operating table in his basement. The instruments and gloves are ready and work begins at once.

The procedure for preparing the dog is as follows: A canvas bag with a draw string is placed over the animal's head to prevent biting. The forelegs are tied together and this rope passed around a post. The hind legs are then tied together and the rope tied around another post and drawn snug so that the dog lies on the floor, stretched between the two posts.

The anesthetic solution consists of 15 Gm. of chloretone dissolved in 100 cc. of rubbing alcohol. The initial dose is ½ cc. per pound body weight and this amount is drawn into a 10 cc. unbreakable veterinary syringe with a large gauge needle and is injected in a single dose into the peritoneal cavity. Deep surgical anesthesia is present in from seven to ten minutes and the dog is then ready for the operating table. Occasionally, a second injection consisting of ¼ to ½ of the initial dose is necessary. This may have to be repeated once or twice during the morning. Anesthesia has thus been maintained in our experience for from six to seven hours, at the end of which time the condition of the animal was still quite satisfactory. We have lost only one dog by anesthesia death and this was due to an error in calculation which resulted in an initial overdose.

This form of anesthesia is convenient, inexpensive and highly satisfactory, requiring no anesthetist during the operations. In the event that narcosis becomes too deep while the work is in progress the peritoneal cavity is washed out with normal saline and

a few minutes of artificial respiration have sufficed, in our experience, to revive the animal.

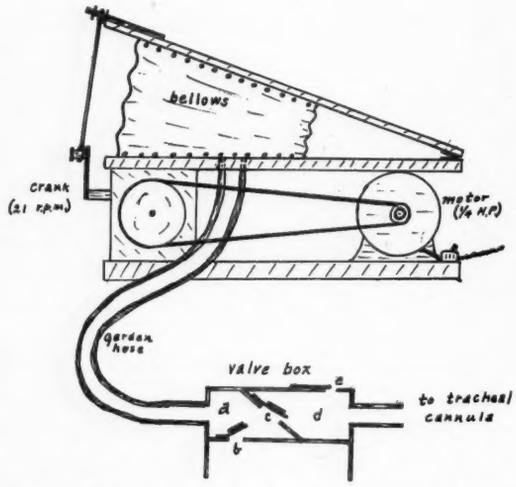

FIG. 1. Diagram of respirator for surgical procedures in the dog's thoracic cavity.

The operating table is home made with a top that measures forty-six inches long by twenty-two inches wide. This leaves a space at one end for instruments. The dog lies upon his back and a rope around each leg is tied to the table beneath. The abdomen is shaved and draped with towels. This completes the work of our assistant until the time comes for disposal of the remains.

At the close of the operation the dog is killed by any of several means, the simplest being to leave the pleural cavity open for a few minutes.

Training in the more recently developed field of thoracic surgery is apt to be lacking in the experience of many competent general surgeons. Dog surgery affords valuable practice here. However, unlike the human structures, the dog's mediastinum and pericardium are thin friable membranes, and it is impossible to expose the heart or one lung without collapsing both lungs. Thus a respirator becomes necessary.

Most respirators for animal work operate on compressed air or vacuum lines which are available in many large laboratories. Such is the principle of an ingenious device made from a windshield wiper designed and demonstrated to us recently in Dr. Claude S. Beck's laboratory at Western Reserve University.

The apparatus we employ (Fig. 1) requires no pressure or vacuum line. It is simple to construct, inexpensive and operates on any light circuit. The gears and crank are from an old washing machine, and together with the motor may be obtained for about five dollars from any dealer in washing machines. The pulleys selected are of such ratio that the crank makes twenty-one revolutions per minute and operates a bellows which handles about two liters of air. A garden hose connects the bellows to the valve box and this in turn connects to a tracheal cannula inserted by tracheotomy.

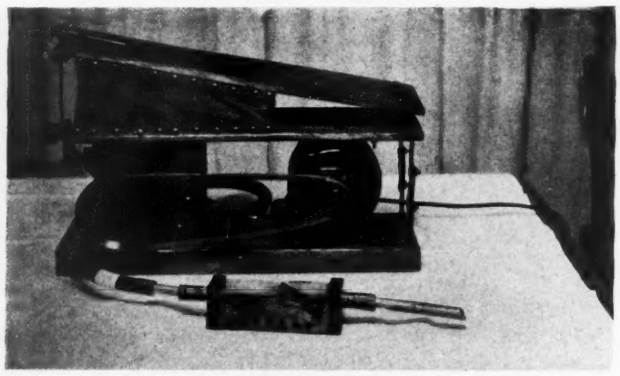

FIG. 2. Photograph of homemade respirator employed by the authors.

Fresh air is insured and overdistention avoided by means of the valves and vent as illustrated. Our earlier work was done without valves, but the addition of this unit gives much better results. We have found

that overdistention of the lungs proves fatal to the dog—a warning to those who use positive pressure methods on human patients.

The mode of operation of the respirator is as follows:

Tracheotomy is done and the inserted cannula connected with a short hose to chamber *d*. Vent *e* is open and the dog breathes through here. The motor is started and, as the bellows close, air enters chamber *a* and passes through valve *c* into chamber *d* where it, too, escapes via the vent *e*. As the bellows open, valve *c* closes and fresh air enters at valve *b*.

The thorax is now opened and the lungs observed as they collapse. Partial closure of vent *e* is now commenced and checked at the point where the lungs fill gently without rounding the margins, which should remain as rather sharp edges. The elasticity of the lungs will collapse them, causing exhalation through the remaining aperture at vent *e*. No negative pressure from the machine is needed. If for any reason ether anesthesia is preferred, an "ether bottle" may be cut into the circuit between the valve box and the cannula. The valves consist simply of holes with leather flaps on which small coins are glued.

The apparatus is rugged and dependable and can be used by a surgeon working without assistance.

It is our sincere hope that the foregoing account may induce others to avail themselves of this opportunity for practice in surgical technics.

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THE PHILLIP'S RECESSED HEAD SCREW

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THE widespread revival of the use of internal metallic fixation in the treatment of fractures which has followed the work of Venable and Stuck on the minimal tissue reaction when using vitallium has brought the mechanical difficulty of internal fixation again to mind. The long period elapsing between Venable's work and the disuse of internal fixation because of the numerous nonunions and low grade infections resulting from the original Lane plate did not of course stimulate a search for better mechanical methods to introduce such fixation onto bone. Many who have been using internal screw fixation probably have had the same trouble that we have had in driving the screw into bone in wounds which are always somewhat bloody, because the screw head becomes slippery and the ordinary screw driver will often, during the application of a single plate, slip off the screw and jab into the patient's unprotected soft parts, much to the annoyance of the surgeon and actual damage to the patient.

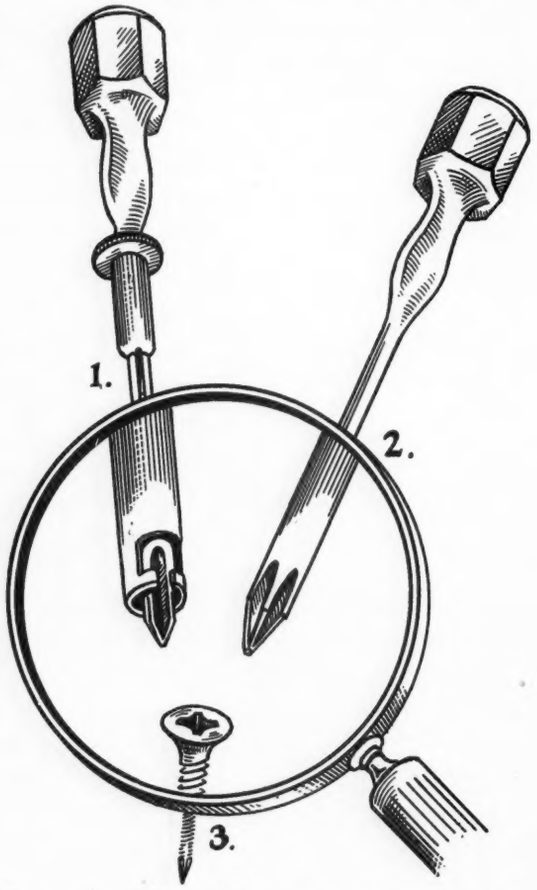

FIG. 1. 1, Self-retaining screw driver with the Phillip's head; 2, ordinary driver with Phillip's head; 3, Phillip's recessed head screw made of vitallium. Note it is impossible for driver to slip off this screw head.

Three years ago a screw called the Phillip's recessed head screw was brought out in industry primarily for use in putting together highly finished automobile parts because the automobile mechanics were having this same trouble of slipping. The head of this screw has not a single slot but a double one, the slots being at right angles to one another so that a driver head made accurately to fit this screw head cannot slip off. With the idea of applying this same principle to the use of vitallium we have some months ago had a driver and screws cast on this principle and have been highly gratified by their use. The time of driving the screw is much less; the driver never slips off the screw and jabs the patient, and the actual asepsis is better because the surgeon is not tempted to use his free hand to steady the end of the driver in the slot in the screw. The illustration shows plainly how this principle is applied.

THE ELIMINATION OF AIR BUBBLES FROM INTRAVENOUS APPARATUS BY A MODIFICATION OF THE MURPHY DRIP

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Surgeon-in-Chief, Windham Community Memorial Hospital
WILLIMANTIC, CONNECTICUT

THE apparatus used for giving fluids intravenously is essentially the same in all hospitals. An inverted flask containing the desired solution is connected by rubber tubing, or directly, to a glass bulb of the Murphy drip type. This, in turn, is connected by tubing of various lengths to the needle which is inserted into the vein. The rate of flow is regulated by a small clamp on the rubber tubing either above or below the Murphy drip glass bulb.

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 1. Usual type of dripper. FIG. 2. Modification A. FIG. 3. Modification B.

Before the needle is inserted into the vein an attempt is made to eliminate all air from the tubing below the bulb. This can be done in several ways and each individual soon develops a technic of his own. Each method, however, is more or less time consuming, and various amounts of solution are wasted. At times it is difficult and annoying to eliminate small bubbles from the tube.

The Murphy drip (Fig. 1) was originally intended and used for the rectal administration of fluids so that the elimination of air bubbles constituted no problem. When used, however, for intravenous therapy the Murphy drip has a definite defect. The small glass tip or dropper projects into the bulb in a straight line, so that when fluid is allowed to run from this tip through the bulb, the solution carries with it air from the glass chamber into the tubing.

If, however, the glass dropper is curved (Fig. 2) and the solution directed to the side of the glass bulb, practically no air is carried into the tube. The same result can be achieved by using a straight glass tip and directing the solution to the side of the bulb by indenting a small area of the bulb itself. (Fig. 3.)

In using these bulbs the flask containing the solutions is inverted with the clamp on the tubing closed tightly. The clamp is then opened widely, allowing a full stream of fluid to run down the side of the glass bulb. Within a few seconds the tubing is free of all air bubbles and only a tablespoonful of the solution is wasted. Both types of bulbs have been used at the Windham Community Hospital with great satisfaction.

MODIFIED BRAUN PERINEAL SCISSORS

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Caylor-Nickel Clinic
BLUFFTON, INDIANA

FOR surgeons who, after incising the peritoneum with a knife, prefer to lengthen the incision with scissors we have modified the Braun perineal scissors so that they are more adaptable for this purpose.

In the original Braun scissors one blade of the cutting edge was set at right angles to the other. (Fig. 1, no. 1.) By adding a nib to the lower flat blade of the shears we have, we believe, improved the instrument.

In opening the peritoneal cavity after the peritoneum is nicked with a knife this modified Braun shears (Fig. 1, no. 2) can be inserted; and because of the nib and flat blade the omentum, loops of bowel and other structures that commonly tend to impede this step are easily pushed aside. The incision can then be rapidly and safely completed.

We have used this instrument for many months with great satisfaction.

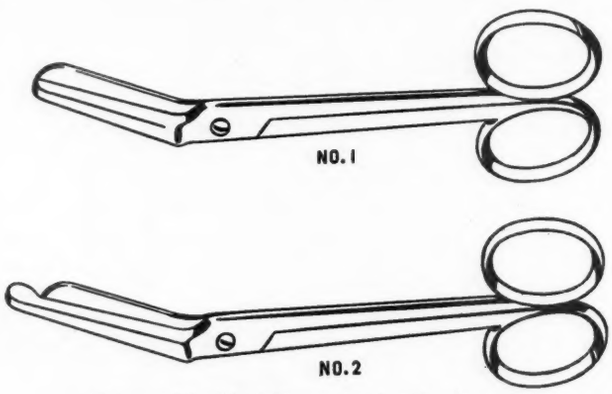

FIG. 1. Modified Braun perineal scissors.

Selected Book Review

OPERATIVE SURGERY*

EDITED BY FREDERIC W. BANCROFT, A.B., M.D., F.A.C.S.

WE quote in part from the Preface: "The purpose of this volume is to present surgical treatment of abdominal diseases together with such important subjects in the general field as anesthesia, pre- and postoperative treatment, the fundamental principles of surgical technic and blood transfusion. . . . We are fortunate in having the collaboration of authors whose high attainments in their chosen specialty enable them to best present their respective subjects and the technic of operations that have proved to be of the most value. . . . They represent the best surgical thought of today . . . one can choose only one author for a given subject, while there are many other excellent authorities whose absence we regret. . . . The subject matter is entirely of surgical treatment and is not concerned with etiology, pathology or diagnosis with the exception of the surgery of the spleen. Emphasis is placed on presenting the best methods by masters of each subject and not encouraging unnecessary surgery." Thus we have the blueprint.

R. Charles Adams did the chapter on Intravenous Anesthesia; Arthur W. Allen wrote on Surgery of the Small Intestine; Anthony Bassler on Dieting for Abdominal Conditions in Which Operations Have Been Performed; Woolfolk Barrow on Appendicitis; Alfred Blalock on Preoperative and Postoperative Treatment; Donald E. Brace on Preanesthetic Medication; Frederick A. Coller on The Treatment of Peritonitis and Peritoneal Abscesses; John H. Garlock on Surgery of the Esophagus; A. Stephens Graham on The Colon and Rectum; Roscoe R. Graham on Surgical Therapy in Lesions of the Stomach and Duodenum; Fraser B. Gurd on Abdominal Incisions; Robert Hayward Kennedy on Surgery of the Mouth; Edward M. Kent on Jejunal Ulcer; Urban Maes on Surgery of the Spleen; Samuel McLanahan on The Anus; Alton Ochsner on Appendicitis;

*New York, 1941. D. Appleton-Century Company, Inc.

William Barclay Parsons on Diseases of the Pancreas; Damon B. Pfeiffer on Jejunal Ulcer; Fred W. Rankin on The Colon and Rectum; I. S. Ravdin on The Surgery of Diseases of the Liver;

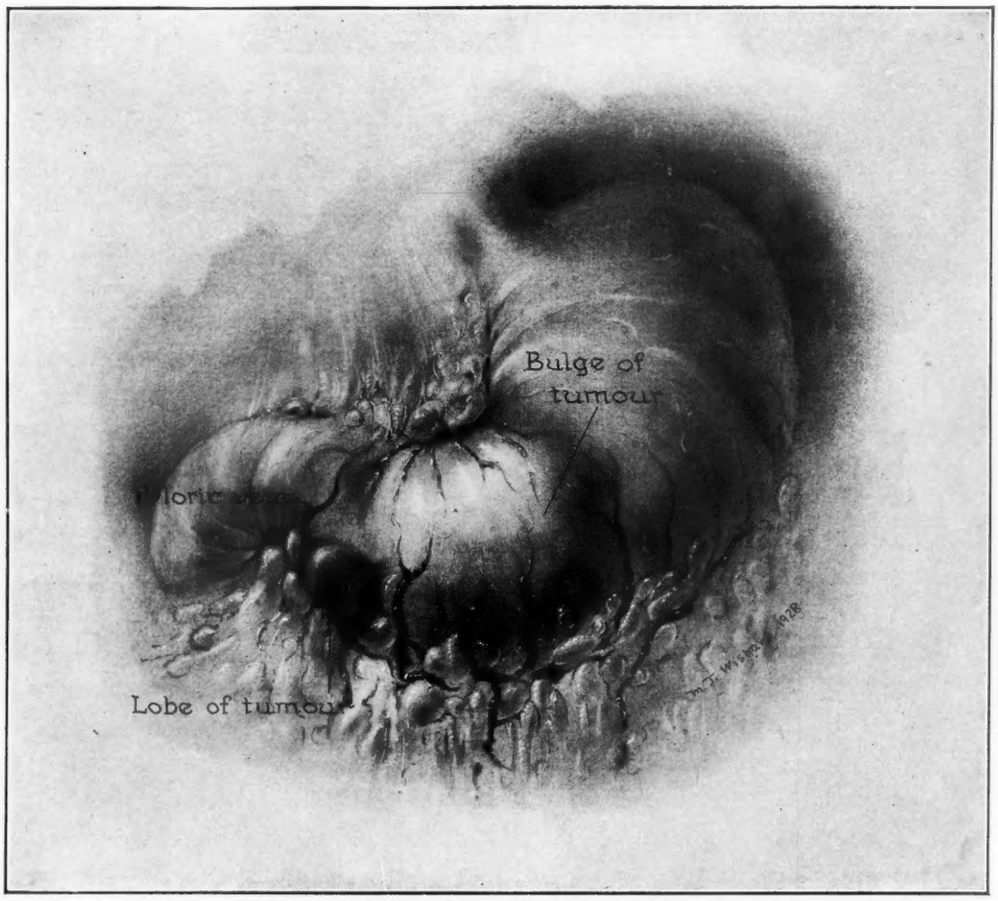

FIG. 1. Intramural neurofibroma of the pylorus. Illustrates the large proportions which benign tumor of the stomach may reach before producing symptoms. In this instance the multilobular tumor was a neurofibroma producing massive hemorrhage. (Fig. 36, on page 628, in Bancroft's "Operative Surgery." D. Appleton-Century Company, Inc.)

Mont R. Reid on The Fundamental Principles of Surgical Technic; James D. Rives on Surgery of the Spleen; D. E. Robertson on Congenital Pyloric Stenosis and Trauma of the Duodenum; Henry S. Ruth on Regional Anesthesia; Rudolph Schindler on The Significance of Gastroscopy for the Surgeon; H. J. Shields on Spinal Anesthesia; Rufus E. Stetson on Blood Transfusion; Jean M. Stevenson on The Fundamental Principles of Surgical Technic; Harvey B. Stone on The Anus; Claude E. Welch on Surgery of the Small Intestine; Allen O. Whipple on Surgery of the Biliary Tract; Sidney Cushing

Wiggin on Inhalation Anesthesia; and Paul M. Wood on Rectal Anesthesia.

We are sure that in listing the authors and their subjects the

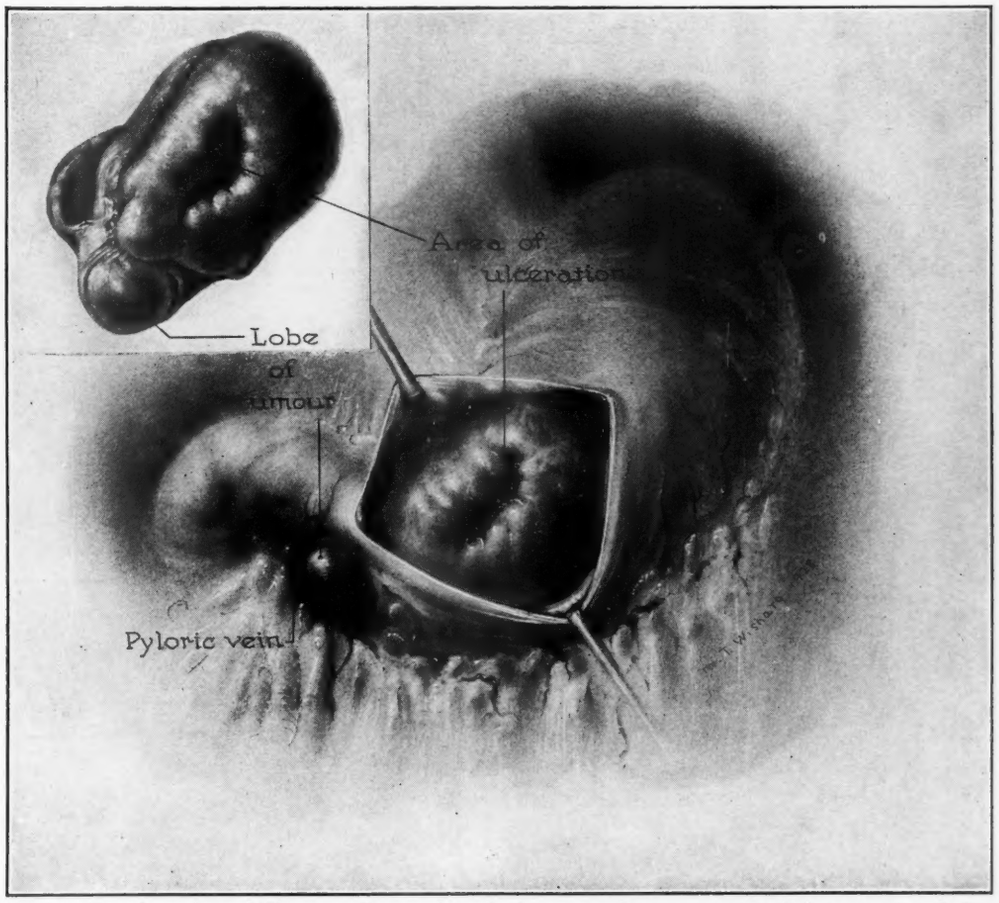

FIG. 2. Continuation of Figure 1. Presenting the intragastric appearance of the tumor and also the tumor enucleated. The area of ulceration represents the source of hemorrhage. This patient, operated upon twelve years ago, is perfectly well. (Fig. 37, on page 629, in Bancroft's "Operative Surgery." D. Appleton-Century Company, Inc.)

reader will get a correct prospective of the work as a whole. To deal with each author and his subject would cause this review to reach the length of a small monograph. Suffice it to say that each and every author has done a thorough and workman-like job of the task given him. The book as a whole is good reading; that it is authoritative cannot be questioned.

The book, containing 1,102 pages, has hundreds of illustrations some of which are in color, and these illustrations are far above the usual level in perfection of detail. There are references at the end of each chapter and there is an ample Index.

Up to this point we have been factual. However, we believe that the reader, if interested in operative surgery, will be impressed that this is an unusual work, of a high order of merit, and the last word to

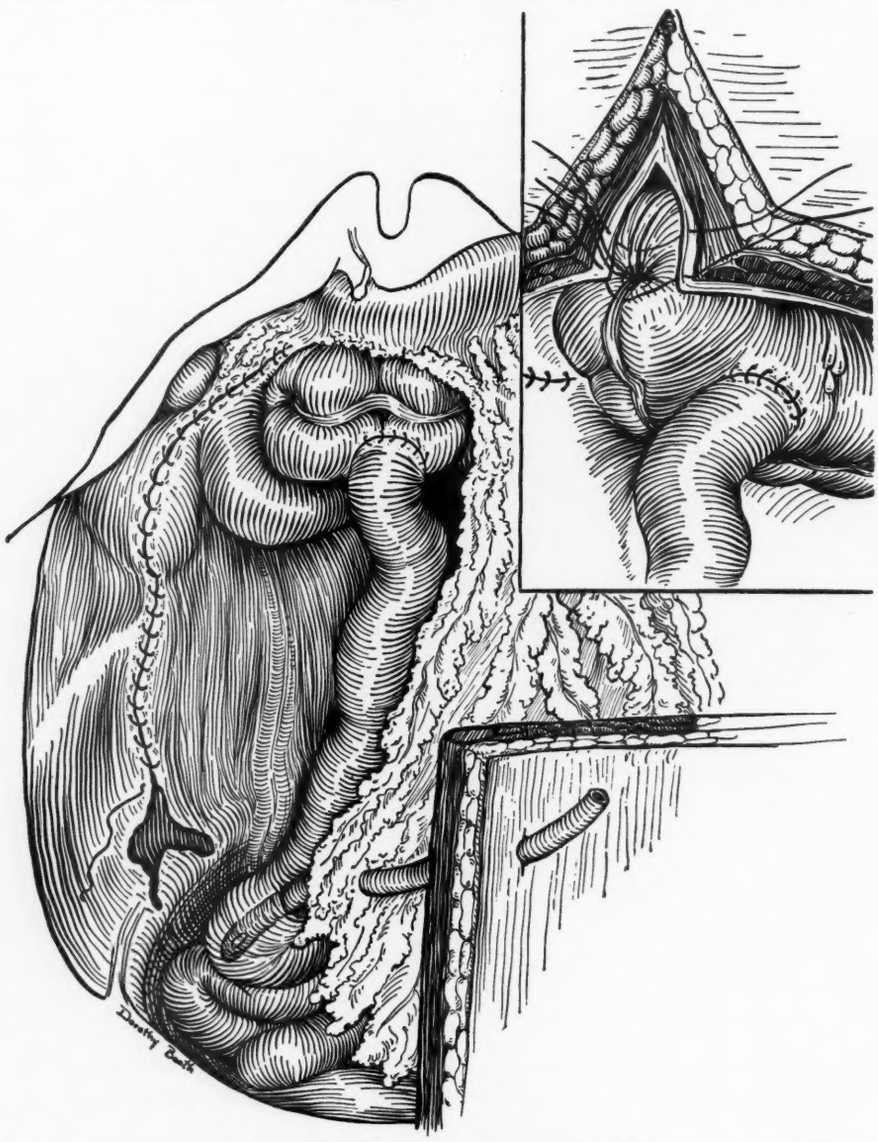

FIG. 3. Resection of the right half of the colon completed and the raw surfaces left by the dissection have been closed by a continuous suture. Insert shows inversion of divided end of transverse colon. (Fig. 11, on page 837, in Bancroft's "Operative Surgery." D. Appleton-Century Company, Inc.)

date on the topics included between its covers. From every viewpoint, it is one of the outstanding surgical volumes published this year.

SPECIAL MONOGRAPH

CANCER
of the
GUMS (GINGIVAE)

BY

HAYES MARTIN, M.D.

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AMERICAN JOURNAL OF SURGERY, Inc.

NEW YORK • MCMXLI

TABLE OF CONTENTS

ANATOMY OF THE GUMS 770
ANATOMY OF THE LYMPHATICS OF THE GUMS 770
ETIOLOGY 773
SYMPTOMS, MORBID ANATOMY AND CLINICAL COURSE 776
Extension of the Growth 777
Metastasis 779
Systemic Metastases 779
Double Primaries 780
Cause of Death 780
Melanoma 780
HISTOPATHOLOGY 781
DIAGNOSIS 781
Delay in Diagnosis 782
Dental Abscess or "Gum Boil" 782
Giant Cell Epulis 783
Granulation Tissue Epulis and "Pregnancy Tumor" of the Gums 783
Fibrous Epulis 783
Leukemia 783
Syphilis 784
Miscellaneous Benign Tumors 784
TREATMENT OF THE PRIMARY LESION IN CANCER OF THE GUM . 784
General Hygienic Measures 785
Treatment by Radiation 786
Treatment by Surgery 788
Combinations of Surgery and Radiation 792
TREATMENT OF METASTASES IN CANCER OF THE GUM 792
Prophylactic Treatment 792
Treatment of Clinically Demonstrable Metastases . . . 794
PROSTHETIC REPAIR OF DEFECTS OF THE MAXILLA, PALATE AND MANDIBLE 796
COMPLICATIONS 798
Radionecrosis and Osteomyelitis 798
Dental Complications 799
Pain 800
Hemorrhage 800
PROGNOSIS 801
END RESULTS 803
SUMMARY 805
REFERENCES 805

CANCER OF THE GUMS (GINGIVAE)*

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CANCER of the gums as a distinct anatomic form of intra-oral cancer has received less attention in the medical literature than its relative frequency merits. Its importance has been overshadowed by the greater emphasis placed upon such better known entities as cancer of the lip and of the tongue, and its identity has been further obscured by a lack of clear definition and its inclusion with a group of tumors of adjacent bony and soft parts under the vague term, "cancer of the jaw."

The present report is based upon an unselected and consecutive group of 113 cases of cancer of the gums, including all-comers in all stages of the disease who applied to the Memorial Hospital between the years 1929 and 1935, inclusive.

Definition.† The term, "cancer of the gums" (gingivae) should be used to designate all malignant tumors arising in the soft tissues

* From the Head and Neck Service, Memorial Hospital, New York City.

† In the medical literature, gingival cancer is described under a variety of titles, such as cancer of the *jaw*, the *alveolus*, the *alveolar border*, the *alveolar ridge*, the *alveolar process*, the *maxilla* or the *mandible*. Cancer of the upper gum is often discussed with cancer of the antrum and/or palate, with no distinction between those growths which arise in the epithelium of the gums and perforate into the antrum, and those which arise in the antrum, erode the alveolar process and perforate onto the gum surface. Reports on cancer of the lower gum often include tumors of bone and of the dental organ. As in all varieties of intra-oral cancer, the greatest confusion results when more than one anatomic group is reported (under such titles as cancer of the "lip and jaw," "tongue and jaw," etc.) without separation of the data.

Much of the confusion in terminology results from the use of the vague term, "jaw," when referring to the gums, or from misdirected attempts to clarify the problem by the substitution of "alveolus," "alveolar border," "alveolar process," etc., rather than the correct term, "gum," which is apparently considered inelegant and unscientific. According to Webster, the term jaw or jaws includes the bone—maxilla and/or mandible—the teeth and the soft structures covering them. This term is, therefore, too inclusive. In anatomical texts there is only one term which defines the soft tissues covering the alveolar processes of the maxillae and mandibles, namely, the *gums*. The term, *alveolus*, refers only to a tooth socket, the terms, *alveolar process* and *alveolar border*, refer only to parts of the bone of the maxillae and mandible.

The confusion in terminology is obvious even in foreign literature. Certain French authors speak of cancer of the "machoire" (jaw) and "mandibule" instead of "gencive" (gum). German authors commonly designate cancer of the gum as "Kiefercarzinom"

overlying the alveolar processes of the upper and lower jaws. Tumors of the gums should be distinguished from those which arise in the bone structure of the maxillae and mandibles and in tooth structures.

The term "epulis" originally referred to all swellings and tumors in this area, particularly to "gumboils" but also to tumors of the bony alveolar processes which surround the alveoli (tooth sockets). At the present time the word bears a more restricted meaning, and in general is used to designate benign tumors of the gums (giant cell epulis, granulation tissue epulis, fibrous epulis, etc.) Etymologically there is no objection to the term, "epulis cancer."

ANATOMY OF THE GUMS

The gums are composed of a thin layer of soft tissue (1 to 2 mm. in thickness) covering the alveolar processes of the maxillae and mandible. The borders of the gums are not sharply defined, but approximately they are delimited (a) on their outer surfaces by the reflection of the mucous membrane onto the cheeks and lips in the depths of the gingivo-buccal gutters and (b) on their inner surfaces by the reflection of the mucous membrane onto the hard palate and onto the floor of the mouth from the upper and lower gums, respectively.

In structure the gums consist of dense, fibrous tissue united internally with the periosteum and covered externally by mucous membrane. They are richly supplied with blood vessels but sparsely with nerves and are covered by stratified squamous epithelium containing numerous papillae, especially in the margins where the gums join the teeth. Around the neck of each tooth the gum forms a free, overlapping collar which is continuous with the alveolar periosteum (peridental membrane) or root membrane of the teeth.

ANATOMY OF THE LYMPHATICS OF THE GUMS

The lymphatic drainage differs in the upper and lower gums and also on their outer and inner surfaces. (Fig. 1.) Anatomists[26,27,29] differ somewhat in regard to the more intimate details of this net-

(jaw carcinoma), although in German dictionaries there is a word "Zahnfleisch" to designate the gums. Kaufmann (Spezielle Pathologische Anatomie. Vol. 1, p. 533. Berlin, 1931. Walter de Gruyter & Co.) speaks of "Krebs des Zahnfleisches" and also refers to "epulis carcinomatosa." In recent Italian literature there is reference to "epiteliomi gengivali," which appears to have the same significance as "gingival cancer."

work, but from the practical standpoint these details are of only minor importance.

1. *The Upper Gum.* (a) *External or vestibular surface:* (Fig. 1A). The lymphatics of the external surface of the upper gum are continuous with those of the mucosa of the cheek and anastomose across the midline anteriorly. On either side the finer network and collecting tubules unite to form a plexus which runs backward and laterally along the gingivo-buccal gutter to enter the cheek. The vessels of this plexus then pierce the buccinator muscle along its superior attachment and reach the anterior facial vein, which they accompany to the submaxillary region, where they enter into the various nodes of the submaxillary group. The lymph vessels from the anterior portion of the upper gum occasionally run to the preglandular lymph-node, but the main lymphatic drainage from the entire structure goes to the prevascular and retrovascular nodes. In the present series, metastases from the upper gum appeared first in the prevascular submaxillary node in 39 per cent of the cases with metastasis. (b) *Internal or lingual surface:* (Fig. 1B). The lymphatics of the inner surface of the upper gum are continuous with those of the hard and soft palates. The main drainage passes backward beneath the mucosa of the retromolar triangle and posterior part of the cheek to the anterior border of the ascending ramus of the mandible. The lymphatic trunks then incline backward and downward, passing to the inner side of the submaxillary salivary gland, and terminate in the subdigastric nodes of the internal jugular chain.

According to Rouviere,[26] there are two other inconstant routes: first, the anterior pathway by which a few lymphatic vessels from the upper gum, after leaving the retromolar triangle, pierce the buccinator muscle and go to the pre- and retrovascular nodes and, second, the posterior pathway where a few lymphatics from the upper gum pass posteriorly to the retropharyngeal nodes. In our clinic we have never been able to demonstrate clinically the presence of metastases in the retropharyngeal lymph-nodes from any part of the oral cavity or pharynx, although one must concede that enlargement of the retropharyngeal nodes would in most cases be difficult to distinguish from a generalized swelling or edema of the posterior pharyngeal wall so commonly found associated with cancer in this region.

2. *The Lower Gum.* (a) *External or vestibular surface:* (Fig. 1C). The lower external gingival lymphatic network, like that of the

upper, forms a plexus in the lower gingivo-buccal gutter which anastomoses across the midline anteriorly. In the gingivo-buccal gutter on each side the vessels pass laterally into the cheek, join the

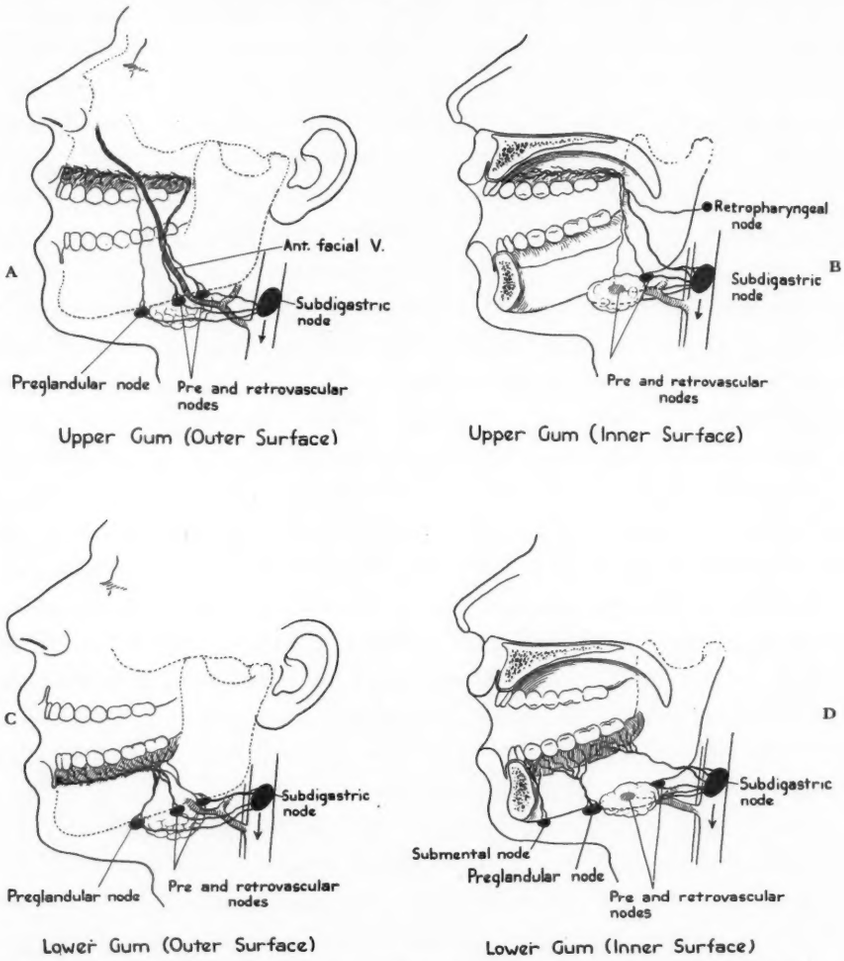


FIG. 1. A, B, C and D, *lymphatic system of the gums.* The lymphatics of the gums drain to the submaxillary and upper deep cervical nodes. The pre- and retrovascular nodes and the subdigastric nodes receive drainage from all of the gum surfaces. The preglandular submaxillary node receives drainage from all except the inner surface of the upper gum. The submental node receives drainage only from the anterior inner surface of the lower gum. The retropharyngeal node receives drainage only from the upper gum.

lymphatics of the cheek, and pierce the buccinator muscle to drain into the prevascular node and, in most cases, into the preglandular and retrovascular nodes as well. (b) *Internal or lingual surface:* (Fig. 1D). The internal vessels make up part of the lymphatic network of the floor of the mouth and undersurface of the tongue; the

larger vessels pierce the myelohyoid and drain mainly into the preglandular node of the submaxillary group. Considerable drainage from this area, especially from the posterior portion, passes directly to the subdigastric nodes of the internal jugular chain. A small part of the lymph from the anterior inner surface of the lower gums passes into the submental nodes with the drainage from the adjoining floor of the mouth.

ETIOLOGY

General Incidence. According to the admission records of the Memorial Hospital, cancer of the gums makes up about 10 per cent of all malignant tumors of the mouth, 7 per cent of all those of the upper respiratory and alimentary tract, and 2.5 per cent of all human cancer. Its incidence is about the same as cancer of the cheek. Kirkham, of Texas,[14] states that gingival cancer is more common in the negro than in the white race, although he gives no figures to prove his claim. In animals, gingival cancer makes up almost 30 per cent of all malignant tumors of the oral cavity,[17] about three times the proportion in human beings.

Age and Sex. The average age of the 113 patients in the present series was sixty-one years, which is slightly older than that of other forms of intra-oral cancer (lip fifty-six, tongue fifty-eight, cheek sixty). The youngest patient was twenty-two and the oldest sixty-six. The disease is definitely more common in the older age groups; almost 70 per cent of the tumors occurred after the age of sixty and only about 2 per cent under the age of forty. About 82 per cent of the patients were males, and 18 per cent females, a relative incidence identical with that reported by Edling[5] in forty cases.

Position of the Growth. In the present series the lower gum was affected in 54 per cent of the cases, the upper in 46 per cent. Gaini[8] has recently reported a series of fifty-three cases in which 68 per cent of the tumors occurred on the lower jaw. The region of the third molar was the most common site of origin (about 60 per cent) in the present series with the region of the bicuspids and canine teeth next in order. Relatively few lesions (5 per cent) arose near the midline anteriorly. Forty-two per cent of the growths were located on the right side and 58 per cent on the left. Janeway, in 1918,[12] reported seventeen cases of cancer of the "superior maxilla" from the Memorial Hospital, of which twice as many occurred on the right as on the left.

Since most growths are fairly well advanced on admission, it is sometimes difficult to determine the exact point of origin; but from the position of the smaller lesions and from the direction of the greatest extension in the larger ones, it appears that the apex of the gum is most often the primary site, and that if the lesion arises definitely on one or the other side, the outer surface is the point of origin about twice as frequently as the inner. In 90 per cent of all cases extension had taken place to neighboring structures on admission, which is to be expected since the gums are relatively narrow (2 to 2.5 cm.) and the average diameter of the primary lesions was 3.3 cm.

Causative Factors. An analysis of the causative factors in the present series fails to reveal any marked variation between cancer of the gums and of other parts of the oral cavity except that the percentage of syphilis is not so high. The cumulative effect of several forms of chronic irritation is obviously of more importance than the action of any one irritant. The older mean age in the present series may be simply fortuitous, or it may indicate that gingival cancer develops only after long continued chronic irritation. Neither syphilis nor tobacco appears to be an important factor in the present series. In animals the high relative incidence of cancer of the gums as compared to cancer of other parts of the oral cavity might provide the basis for an interesting investigation—or at least speculation—on the effect of differences in dietary habits in animals and in man. This question, however, is beyond the scope of the present report.

Tobacco. As with all forms of intra-oral cancer which have been analyzed at the Memorial Hospital, about 70 per cent of the patients with gingival cancer give a history of using tobacco. This figure approximates the incidence of the habit in the general male population, and therefore is of little etiologic significance. Edling,[5] of Lund, Sweden, reported a large proportion of tobacco-chewing farmers among his cases of gingival cancer, but the chewing habit does not appear to be common in New York City or the eastern United States, since at the Memorial Hospital the coincidence of tobacco chewing and intra-oral cancer is rare.

Syphilis. In ninety cases of the present series in which Wassermann tests were made as part of the routine examination, positive reactions were obtained in only 3 per cent, a figure which is below that for syphilis in the average male population of the corresponding age group (6 per cent).[30] The fact that it is below the average is

probably only accidental, but at any rate the low figure undoubtedly indicates that syphilis is not a factor in the causation of gingival cancer.

Dental Derangements. A causal relationship between dental derangements and cancer of the gums is undoubtedly more apparent than real. In the first place, if teeth were not present at the site of the growth, there would necessarily be a history of dental defects which led to extraction. Second, if teeth were present when the growth appeared, the patient would naturally believe that the trouble was of dental origin. Third, if the patient wore any form of denture, it would necessarily become ill-fitting in the presence of an underlying gingival tumor, and in such cases a direct causal relationship, even though erroneous, would always be assumed. For these reasons, a history of past or present dental complications can be obtained in most cases, but in the majority their significance is doubtful. In the present series about 25 per cent of the patients first consulted a dentist, and 15 per cent had had teeth extracted during the three months before admission to our clinic. An additional 10 per cent had attributed the development of the growth to ill-fitting dentures. Kirkham[14] reports that in practically all of his cases an erroneous diagnosis of dental abscess had been made before admission, and Gernez[9] states that almost all patients with gingival cancer first consult a dentist.

In pyorrhea alveolaris, primarily a disease of the peridental membrane in the tooth sockets, there is always an associated inflammation of the gums themselves. On the other hand, there are other forms of gingivitis, notably that associated with avitaminoses, which can occur independently of pyorrhea alveolaris. Any of these forms of chronic inflammation of the gums could conceivably be an important factor in the etiology of gingival cancer. However, some degree of gingivitis, probably from a combination of these causes, as evidenced by bleeding of the gums on brushing of the teeth, is almost universal. The manufacturers of tooth paste capitalize upon this fact in their advertisements. The gums and the dental apparatus are among the first structures to deteriorate with the natural aging process in both man and animals, and for this reason such changes cannot be considered as abnormal.

Acute abnormalities of the dental apparatus are self-limited in duration, since they are usually followed by early loss of the teeth and healing of the gums. From the mechanical standpoint, the gums

are not often affected by sharp or broken teeth which are likely to traumatize the border of the tongue or the mucosa of the cheeks. In the final analysis, one must conclude that although diseases and defects of the dental apparatus may possibly play a part in the origin of cancer of the gums, their significance is not great; and it is probable that the same extraneous irritants operate here to cause cancer as in other parts of the oral cavity.

SYMPTOMS, MORBID ANATOMY AND CLINICAL COURSE

The most common first symptom noted by the patients in the present series was the lesion itself (70 per cent), with local "soreness" occurring first in only about 20 per cent. Since the gums themselves are poorly supplied with nerves, pain or discomfort seldom occurs until the growth has extended to neighboring structures. In a few instances, the primary lesion produced no noticeable symptoms whatever, and the patients first consulted a physician because of enlarged cervical nodes (4 per cent).

A patient with cancer of the gum rarely seeks medical advice in the early stages of the disease. In the present series the average size of the growth was 3.3 cm. on admission. (Fig. 2.) In over one-third of the cases the primary lesion was over 4 cm. in diameter, and in only 10 per cent was it less than 2 cm. The average duration of symptoms before admission was 6.2 months.

The lesion begins as a small papillary ulcer, usually on the apex or margin of the gum (sometimes on the buccal surface separate from the margin, less often on the inner surface), which produces neither pain nor other discomfort. When first discovered by the patient, it is likely to be considered a dental abscess. If a tooth is extracted, the growth may progress by way of the tooth socket to invade bone. In other cases, as the tumor enlarges it may interfere with the fit of a dental plate or removable bridge, and the patient, mistaking the effect for the cause, believes that the denture has provoked the lesion. Unless the growth invades the underlying bone through the tooth sockets following extraction, the periosteum proves resistant for some time, and the tumor spreads peripherally into the cheek, hard palate, or floor of the mouth to form a broad, flat, superficial ulcer several centimeters in diameter. In other cases, especially in tumors of lower grade, the periosteum resists invasion and the growth fungates into the mouth.

After a period of several months the periosteum is finally perforated, and then bone is rapidly invaded and eroded. With deep invasion of the mandible, pathologic fracture may result. A growth

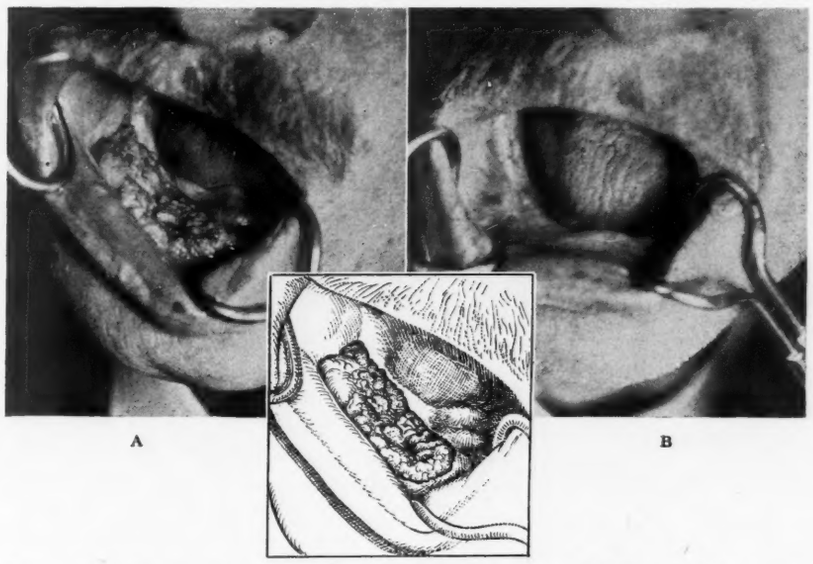


FIG. 2. W. S., age sixty-one, admitted to the Memorial Hospital in 1935. A, the primary lesion, about 3.5 cm. in diameter, involved practically the entire right gum. Diagrammatic insert shows extent of lesion. Biopsy showed squamous carcinoma grade I. B, treatment was by peroral *x*-radiation. The patient has survived five years free of disease.

in the lower gum may extend through the bone to the skin over the outer surface of the mandible or the submaxillary region. Such deep invasion of bone is usually associated with sepsis, both locally and in the submaxillary nodes, so that there is a combination of inflammatory hyperplasia, local cellulitis and metastatic invasion of the submaxillary and upper deep cervical nodes. A combination of these various disease processes makes it difficult to determine the extent of the cancer.

Extension of the Growth. In the present series the disease had extended beyond the gum into the neighboring structures on admission in 90 per cent of the cases. The mucosa and deep tissues of the cheek (Fig. 3) were the most frequently invaded, with the hard and soft palates, the floor of the mouth and one anterior tonsillar pillar next in order. In most instances, more than one of these structures were involved. In 35 per cent of the present cases bone erosion was demonstrable both clinically and roentgenographically on admission. When the growth has once invaded the medulla of the mandible,

it may then progress for several cm. before again appearing on the surface.*

In the upper gum erosion of the maxilla eventually results in

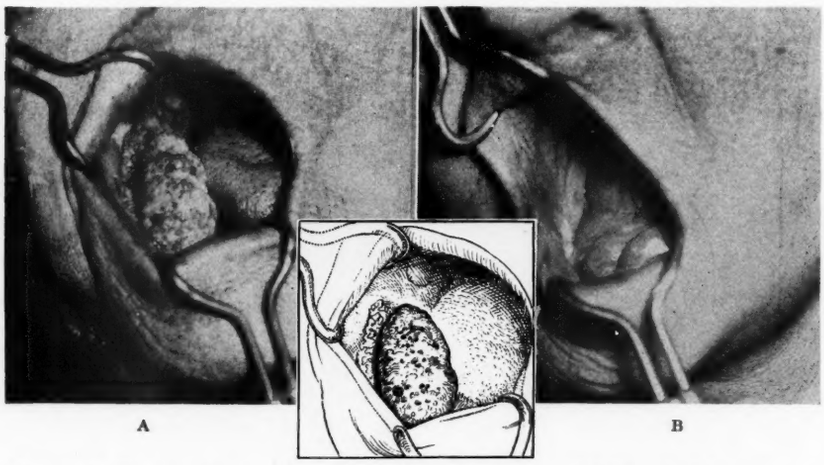


FIG. 3. A. K., age sixty-seven, admitted to the Memorial Hospital in 1934. A, the primary lesion of the right lower gum had deeply invaded the gingivo-buccal gutter and perforated onto the skin surface. Diagrammatic insert shows extent of lesion. Biopsy showed squamous carcinoma grade I. B, treatment was by a combination of *x*-radiation and radon seeds with complete regression. The patient later developed two separate primary cancers of the mucosa of the cheek and of the hard palate, which were excised by cautery.

extension of the disease into the maxillary antrum or nasal cavity. Invasion of the antrum, although almost always associated with purulent infection, seldom leads to marked swelling of the cheek and edema of the periorbital tissues, because the antral wall has been eroded and neither tumor nor pus can produce marked pressure within the cavity. From the anatomic standpoint this observation may be of some value in the differential diagnosis of doubtful cases. After posteriorly situated lesions of the upper gum have invaded the soft palate and cheek, there is sepsis in the region of the pterygoid and temporal tendons, and late in the course of the disease there may be swelling of the entire cheek and temporal region.

* In a recent case I have observed epidermoid carcinoma of the gum which invaded through the socket of an extracted left lower bicuspid tooth and progressed through the medulla of the mandible toward the right, crossed the midline, and then perforated the cortex to appear on the outer surface of the right lower gum opposite the right first molar. This continuous direct extension through the medullary cavity for a distance of about 6 cm. was proved both by roentgenographic examination and by gross and microscopic examination of the surgical specimen of the excised mandible.

Metastasis. In general, the behavior of metastasis in cancer of the gums follows that of other intra-oral cancers. About 35 per cent of the patients in the present series had cervical metastases on admission, which is about the same as the figure reported by Janeway[12] over twenty years ago. An additional 20 per cent developed metastases subsequently, so that 55 per cent had metastatic involvement at some time during the course of the disease, a figure which is only slightly lower than in cancer of the tongue and of the floor of the mouth. In the upper gum, metastases on admission (28 per cent) were less frequent than in the lower (39 per cent), although eventually 61 per cent of the growths of the upper gum metastasized as compared to 51 per cent of the lower. These figures are based upon too small a series to be absolutely conclusive, but in any case they do not confirm the statements of MacFee[15] and Schley[28] that metastasis to the cervical lymph-nodes from cancer of the upper jaw is infrequent.

The pathway of lymphatic drainage and the position of the nodes first involved vary considerably in cancer of the upper and lower gums, respectively. The difference may be adequately explained by the anatomy of the lymphatics, which has already been described. In the upper gum the lymphatic drainage is chiefly to the subdigastric nodes of the internal jugular chain which were involved first in the present series in over half of the cases with metastasis from this area. In a lesser number (39 per cent) metastases from the upper gum appeared first in the pre- and retrovascular nodes of the submaxillary group.

From the lower gum the main drainage is into the submaxillary group (preglandular, pre- and retrovascular) where nodes were involved first in about 65 per cent of the cases with metastasis from this area, with only about 30 per cent occurring first in the subdigastric region. The pre- and retrovascular lymph-nodes lie very close to the primary lesion in cancer of the posterior lower gum, and in advanced cases the two foci of the growth tend to coalesce and invade jointly the adjacent tissues. After involvement of the first "echelon," the disease disseminates to the middle and lower nodes of the jugular chain and to the viscera. Bilateral metastases occurred in only about 4 per cent of the entire series. Johnson,[13] reporting upon 122 cases from the Memorial Hospital clinic in 1925, recorded only one instance of bilateral involvement.

Systemic Metastases. In the autopsy records at the Memorial Hospital there are reports of 284 patients dead of cancer of the upper

respiratory and alimentary tracts. Among these are fourteen cases of gingival cancer, in five of which (35.7 per cent) there was visceral involvement. From these records it appears that visceral dissemination occurs more frequently from cancer of the gum than from cancer of any other part of the oral cavity except the mucosa of the cheek (36.3 per cent).

Double Primaries. As in other anatomic forms of intra-oral cancer, the coincidence of a second primary cancer in another site is not unusual. Multiple cancers occurred in eight of the present series, in one of which there was a separate growth of the gum on the opposite side. In the others the second cancers occurred, respectively, in the skin of the face, tongue, prostate, soft palate, pancreas, breast and sigmoid.

Cause of Death. The terminal symptoms in cancer of the upper gum are about the same as in cancer of the antrum. In cancer of the lower gum, the floor of the mouth and the tongue are invaded, with metastasis or sepsis in the submaxillary lymph-nodes, terminating in cellulitis of the whole submaxillary region. Death ensues from a combination of causes—exhaustion from pain, sepsis, malnutrition, and hemorrhage from the eroded external maxillary and/or mandibular arteries. It is probable that systemic metastasis is more often a factor in causing death than is commonly realized.

Melanoma. Melanoma occurs more often in the gums than in any other part of the oral cavity. In the present series there were four cases, two on the upper gum and two on the lower. One occurred in a male and three in females. The average age was forty-five years, about seventeen years younger than the average for carcinomas (sixty-two years). The average duration of symptoms in these cases was eleven months, five months longer than in the carcinomas.

The clinical appearance of mucous membrane melanoma is fairly characteristic. All of the four tumors were deeply pigmented, smoothly granular and ovoid, tending to fungate from the surface rather than to infiltrate deeply. Except for the pigmentation, they resembled the benign giant cell epulis in appearance. All of the growths metastasized first to the submaxillary lymph-nodes, then widely throughout the neck and eventually systemically. In one case which occurred in a female of forty years, the patient survived without recurrence for four years, when she developed metastases in the lungs and pleura, as shown both by her symptoms and roentgen examination of the chest. She survived the pulmonary metastases for

about fifteen months, during which time she coughed up from the bronchi a mass of granular tissue which was examined histologically and found to be melanoma. All of the cases terminated fatally despite treatment, with an average survival of almost five years, two patients living more than five years.

HISTOPATHOLOGY

Epidermoid carcinomas made up almost 90 per cent of the cases of gingival cancer in the present series, as shown in Table I, with squamous carcinomas, grade II, predominating (62 per cent). As in the lip and cheek, squamous carcinomas, grades III and IV, were rare. Adenocarcinomas arising in minor salivary glands made up about

TABLE I

HISTOPATHOLOGY IN 113 CASES OF CANCER OF THE GUM AT THE MEMORIAL HOSPITAL

Squamous carcinoma grade I	29
Squamous carcinoma grade II	66
Squamous carcinoma grade III	1
Melanoma	4
Lymphoepithelioma	1
Spindle cell carcinoma	1
Adenocarcinoma	5
Lymphosarcoma	1
No disease at primary site on admission	5
Total	113

5 per cent of the cases, with lymphoepitheliomas occurring only occasionally. There were four cases of melanoma in the present series. As already stated, this tumor occurs more commonly in the gum than in any other part of the mouth.

DIAGNOSIS

A biopsy is an essential part of the management of intra-oral cancer, and a specimen should be taken in all cases from any suspicious ulcerated lesion in the mouth at the time of the first examination. Such confirmation of the diagnosis should be mandatory before the patient is subjected to the necessarily aggressive treatment for cancer, either radiologic or surgical, and no claim should be made for cure in cases which are not histologically proved.

Benign tumors which may be confused with cancer, or vice versa, are common in the gums. Their comparative incidence is shown in Table II. In general, their clinical appearance should immediately

suggest their benign nature, but since errors are so frequently made, they will be discussed in detail under separate headings.

TABLE II

COMPARATIVE INCIDENCE OF BENIGN AND MALIGNANT TUMORS OF THE GUM AT THE MEMORIAL HOSPITAL

1929 to 1935, Inclusive

Malignant tumors		108
Carcinoma	103	
Melanoma	4	
Lymphosarcoma	1	
Benign tumors		67
Giant cell epulis	29	
Granulation tissue epulis	23	
Fibrous epulis	12	
Miscellaneous (papilloma, myxofibroma, angioma)	3	

Delay in Diagnosis. At least one-fourth of the patients with gingival cancer first consult a dentist under the impression that the lesion is a dental abscess, commonly known as a "gum boil." In most instances the dentist extracts one or more teeth, whether or not he recognizes the true nature of the condition. Such errors obviously should occur only in the small or moderate-sized lesions, for the malignant nature of the ulcerated and fungating tumors can hardly be missed. Twenty-three patients in the present series (20 per cent) stated definitely that they had first consulted a dentist. In seven of these the dentist suspected that the lesion was a malignant growth and recommended medical consultation. In sixteen of the cases it is obvious that the dentist missed the diagnosis because teeth were extracted or mouth washes prescribed, and in these cases there was an average delay of 6.4 months before a correct diagnosis was made. Fifty-three patients (about 50 per cent) stated that they had consulted a physician first. In thirty-six of these a tentative diagnosis was made and the proper treatment advised. In seventeen it is apparent that the physician did not suspect cancer because the patients were treated with topical applications and mouth washes for varying periods. No average period of delay can be calculated because the patients' statements concerning the time interval were too indefinite.

Dental Abscess or "Gum Boil." This lesion is apparently common in dental practice and is the most frequently confused with cancer when the patient consults a dentist. A dental abscess is always a mound-like, painful swelling of the gums opposite a tooth. Fluctuation and acute tenderness are characteristic, and there is no

ulceration unless the abscess has ruptured or the gum has been incised. By contrast, cancer of the gum is always ulcerated from the beginning and is never painful or tender until the later stages.

Giant Cell Epulis. The most common benign tumor of the gums is giant cell epulis, an infectious granuloma of long duration in which inflammatory giant cells have formed. Giant cell epulis usually occurs as a deep bluish-red, ovoid, partly pedunculated tumor, usually on the outer surface of the gingival margin in close association with a tooth or sometimes in an edentulous gum. The surface may be covered with thin mucous membrane or it may be partly ulcerated, but there is never erosion. The history is usually of several months' duration with no symptom except the presence of the tumor. As long as the growth is not ulcerated, there appears to be considerable growth restraint; but following incomplete removal, there is rapid recurrence from the base. The treatment is local removal with curette and thorough cauterization of the base. It is usually necessary to extract one or more adjacent teeth in order to obtain complete destruction of the base of the tumor.

Granulation Tissue Epulis and "Pregnancy Tumor" of the Gums. Granulation tissue epulidi may appear in either sex and are usually associated with peridental sepsis. They almost always arise on the outer surface of the margin of the gum at its junction with a tooth and may be distinguished from cancer by the history and the characteristic deep-red, granular, pedunculated, non-infiltrating appearance. This lesion is fairly common during pregnancy when it is known as a "pregnancy tumor" of the gum. Exuberant granulomas of the gum are occasionally a feature of the gingivitis which accompanies avitaminosis B. The treatment is the same as for giant cell epulis. Most cases are benefited by the administration of vitamin B.

Fibrous Epulis. This tumor, usually associated with a tooth, appears as a firm pedunculated mass, 3 to 10 mm. in diameter, at the gum margin. The surface is covered by mucous membrane of normal color, and the growth apparently represents a granulation tissue epulis which has become organized. The tumor occurs more commonly in females than in males and is usually situated anteriorly on the outer surface of either the upper or lower gum. The treatment is local surgical removal with moderate cauterization of the base. There is no marked tendency toward recurrence.

Leukemia. The gums are occasionally the site of the first objective lesion in lymphatic or aleukemic leukemia, although the patients

complain mainly of loss of strength. In these cases the gums are swollen, bluish-red in color, and present granulomas of varying size at the margin. Biopsies from these areas may give a picture of lymphosarcoma, but the true character of the disease is shown by a blood count which will reveal the lymphocytosis. Several such cases have been observed at the Memorial Hospital.

Syphilis. The only syphilitic lesion which might simulate cancer in appearance is gumma. Although this lesion can theoretically appear in the gum, there is no case on record at the Memorial Hospital. It cannot be differentiated clinically from cancer, but it is so rare as to be of no diagnostic significance and should not be included in any theoretical considerations, provided that a biopsy is part of every routine examination.

Miscellaneous Benign Tumors. Papilloma, a benign warty epithelial tumor, may occur in any part of the oral mucous membrane. The treatment depends on the individual characteristics of each case and may be either by narrow surgical excision or by superficial cautery. Myxofibroma, hemangiomas and lymphangiomas may occur in the gums but offer no particular problem in diagnosis.

TREATMENT OF THE PRIMARY LESION IN CANCER OF THE GUM

The effectiveness of any form of treatment of cancer of the gum (surgery, cautery or radiation) is dependent upon certain anatomic features which are unique in the gums and hard palate. Growths in these areas arise in a thin layer (1 to 2 mm.) of soft tissue overlying bone. Whether or not the periosteum has been invaded, adequate surgical treatment requires the removal of at least a thin shell of the underlying bone; otherwise there is no assurance that the base of the growth has been removed. In the upper gum, the removal of overlying bone usually means opening into the antrum and sometimes the nasal cavity. This portion of the bone, so near the surface, also limits the possibilities of radiation therapy. In many cases the thinness of the growth over bone makes the retention of interstitial implants impossible or at least uncertain, and therefore the dependence must be placed chiefly upon external radiation. The administration of cancer lethal radiation doses in gingival cancer will at least partially devitalize the underlying bone, subjecting considerable areas to the danger of subsequent radio-osteomyelitis. If the periosteum and bone have been invaded, sterilization of the growth will

inevitably leave the bone exposed, radio-osteomyelitis follows, and sequestration of the bone must take place before healing.

The treatment method in the individual case of gingival cancer should be selected after a full consideration of these limitations and complications. In carcinoma, which makes up over 95 per cent of the malignant tumors of the gum, no single method is suitable in all cases. Radiation, surgery and combinations of the two all have a definite place in the treatment of this disease. In two of the rare histologic types, the indications in the selection of the treatment method are more definite; that is, melanoma should be treated only by surgical excision and lymphosarcoma only by radiation.

In the literature most of the references to gingival cancer are found in articles on cancer of the upper and lower "jaw," and they frequently include antral or bone tumors in the same group. As has already been mentioned, so-called "carcinomas of the jaws" are often grouped with growths of the floor of the mouth, cheek or tongue, and the data are therefore confusing. When the pertinent opinions regarding treatment of gingival cancer are sifted out, they are found to be about equally divided between local excision of the tumor by actual cautery (Crile,[4] Bloodgood,[3] Ochsner[22]) or endothermy (Gernez,[9] Ohngren,[23] Fischel[6]), radiation methods (Johnson,[13] Quick,[25] Ashbury,[2] Janeway[12]), radical resection of the maxilla (MacFee,[15] Meyer,[21] Woodman,[31] Schley,[28] Frenckner,[7] Harmer[10]) and combinations of surgical excision and radiation (Edling,[6] Maurel[20]). Many of the total resections of the upper jaw have probably been done for reasons similar to those for amputation of the extremities at so-called "sites of election." Such a principle is not well conceived when applied to the maxilla, for a line of resection passing through the nasal cavity and the orbit can hardly be considered a "site of election." As far as the comparative merits of any single one of these methods is concerned, one can find no proof in the literature, since none of these authors has given five-year end results on a series of histologically proved cases.

General Hygienic Measures. As in all forms of intra-oral cancer, hygienic care of the oral cavity both before and during treatment is an important factor in a successful result. In the uncomplicated case, local sepsis is superficial and can be controlled by mouth irrigations (q. 2 to 3 hr.) with alkaline-saline solutions (sodium bicarbonate and sodium chloride aa ℥ī to 1 quart of warm water) and cleansing by power sprays (2 to 3 times a day).

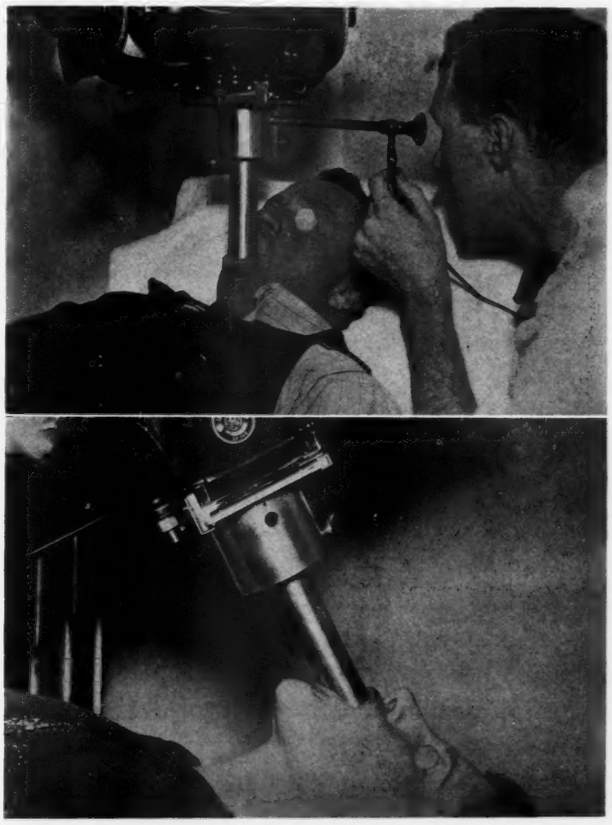
The presence of teeth directly at the site of the primary growth or in the immediate vicinity always constitutes an obstacle not only to the administration of treatment but also to proper hygienic care. The solution of this problem must be individualized in each case. Wholesale extraction of teeth is objectionable for several reasons. First, laceration of the gum opens the tooth sockets to invasion by the growth or by infection following radiation. Moreover, if there is an eventual loss of bone in either the upper or lower jaws, the retention of some sound teeth is invaluable if restorations by mechanical prosthetic appliances are to be used. A few teeth may have to be extracted so as to permit the introduction of the proper sized cylinder for peroral *x*-radiation. Other teeth may be so loose and so involved by dental sepsis that extraction is necessary even though objectionable from some standpoints. In other instances, sound teeth are best amputated at the gum margin, the nerve extracted and the root canals filled, leaving the tooth sockets plugged to guard against invasion by growth or infection.

As with many forms of intra-oral cancer, dietary deficiencies, especially avitaminosis B, accompanied by low grade stomatitis may play an important rôle in the etiology and treatment of cancer of the gum. The malnutrition associated with this condition can be greatly improved by the administration of large doses of the vitamin B complex as, for instance, dried granular yeast in doses of three tablespoonsful (50 Gm.) daily.

Treatment of the Primary Lesion by Radiation. Although there may be definite advantages in surgical removal of the smaller lesions, the fact remains that radiation therapy is the most useful and suitable method of treatment, since in the average case the growth in the gum is situated posteriorly, is over 3 cm. in diameter and involves at least one neighboring relatively inoperable structure. In superficial growths arising in the thin layers of soft tissue overlying bone, external rather than interstitial radiation must be the main form of treatment. Quick[25] has called attention to the mechanical impossibility of deep implantation of interstitial sources and the inadequacy of contact application of radium in cancer of the gum.

At the Memorial Hospital the radiation technic for cancer of the gum consists of (1) peroral *x*-radiation given through the open mouth by the use of metal cylinders, thus avoiding irradiation of the overlying skin, cheeks and lips; (2) supplementary *x*-radiation through accurately centered portals on the skin of the cheek, the tongue and

the opposite side of the mouth being at least partly protected by lead shields placed on the lingual surface of the affected gum; (3) supplementary implantation of small doses of radon seeds in residual disease



A

B

FIG. 4. A, a patient is shown in position for peroral *x*-radiation to a cancer of the lower anterior gum. The surgeon checks the accuracy of the set-up by an electrically lighted periscope, following which the periscope is removed and the treatment administered. B, peroral *x*-radiation for a growth of the upper gum.

in the cheeks or floor of the mouth or, rarely, in the gums themselves. The use of supplementary contact applications of radon in dental compound molds is useful only in rare instances.

After the preliminary extraction or amputation of such teeth as constitute a definite obstacle, peroral *x*-radiation is given through a metal cylinder of the correct size (2.5 to 5 cm. in diameter) to include the primary lesion amply with a margin of at least 1 cm. of surrounding normal tissue if possible. (Fig. 4.) A detailed description of the apparatus and of the advantages of this technic has already been

published.[16] Accurate direction of the beam and centering of the peroral portal is favored by the use of an electrically lighted periscope. (Fig. 4.) For the peroral *x*-radiation of intra-oral cancer we have used both high voltage *x*-ray (200 to 250 kv., filter 0.5 to 1.5 mm. Cu) and low voltage *x*-ray (100 to 120 kv., no filter except the tube wall, 1 mm. Al eq.) at the shortest target skin distance (15 to 35 cm.) which can be obtained within the mechanical limitations of the apparatus. The treatments are given daily or at least three times a week. The individual dose in roentgens depends upon the correlation of such physical factors as the voltage, the size of the portal and the frequency of the treatments. On an average the total dose in about twenty to twenty-five days with high voltage radiation (200 to 250 kv.) is from 5,000 to 7,000 r; with low voltage radiation (100 to 120 kv.) the total dose over the same period is 10,000 to 15,000 r.

In most cases peroral *x*-radiation to the gum as described above is combined with external radiation given through the skin of the cheek, the exact center of the portal being carefully determined and marked on the skin by a small tattoo mark.* Treatments are given to the two ports on alternate days, the daily dose depending on the size of each portal. The external portal should be kept to a minimum size (3.5 to 5 cm. in diameter), just large enough to cover the primary lesion with a margin of about 1 cm. A total dose of 4,000 to 5,000 r is given to this portal over a period of three weeks. At the completion of this *x*-radiation, subsequent treatment depends upon the amount of reaction in the normal tissues and the regression of the tumor. In some instances further external radiation may be given. If only a small nodule of residual disease can be palpated in the margin, it is often best to implant a few radon seeds (2 to 5 of 1 mc. each). In rare instances contact application of radon in dental molds might be used after *x*-radiation.

Treatment of the Primary Lesion by Surgery. As has been mentioned previously, it is best to restrict purely surgical removal to small superficial tumors which have not extended into neighboring structures. The technic for the combined use of cautery and bone chisel in these lesions is described in Figures 5 and 6 with their

* The skin is cleansed with alcohol and a small drop of India ink is placed at the selected point. With a sterile, sharp-pointed surgical needle, several punctures are made through the India ink into the skin. Such a mark remains permanently, but its size can be so small as to be unobjectionable.

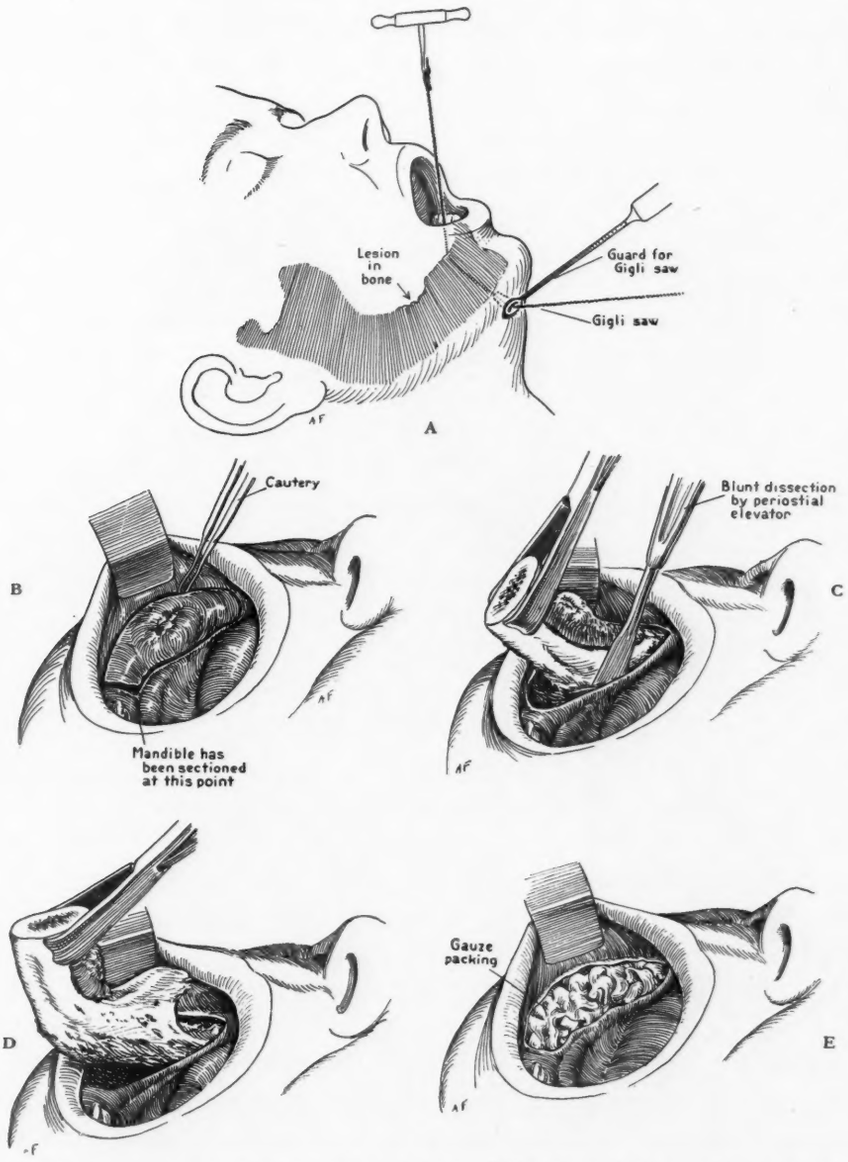


FIG. 5. A, B, C, D and E, *resection of the mandible through the mouth.* A, the mandible is usually sectioned near the symphysis, preferably with a Gigli saw inserted through stab wounds from the floor of the mouth out through the skin of the submental region. The skin is advantageously protected by a specially devised guard. B, after the mandible is sectioned, the mucous membrane surrounding the lesion in the gum is cut through by an actual cautery, leaving a safely wide margin of normal tissue. C, the bone is grasped by a bone-holding forceps and freed by sharp and blunt dissection. D, the attachment of the temporal muscle to the choronoid process is severed and the temporomandibular joint disarticulated by torsion. E, hemorrhage is controlled mainly by packing and the wound is left open.

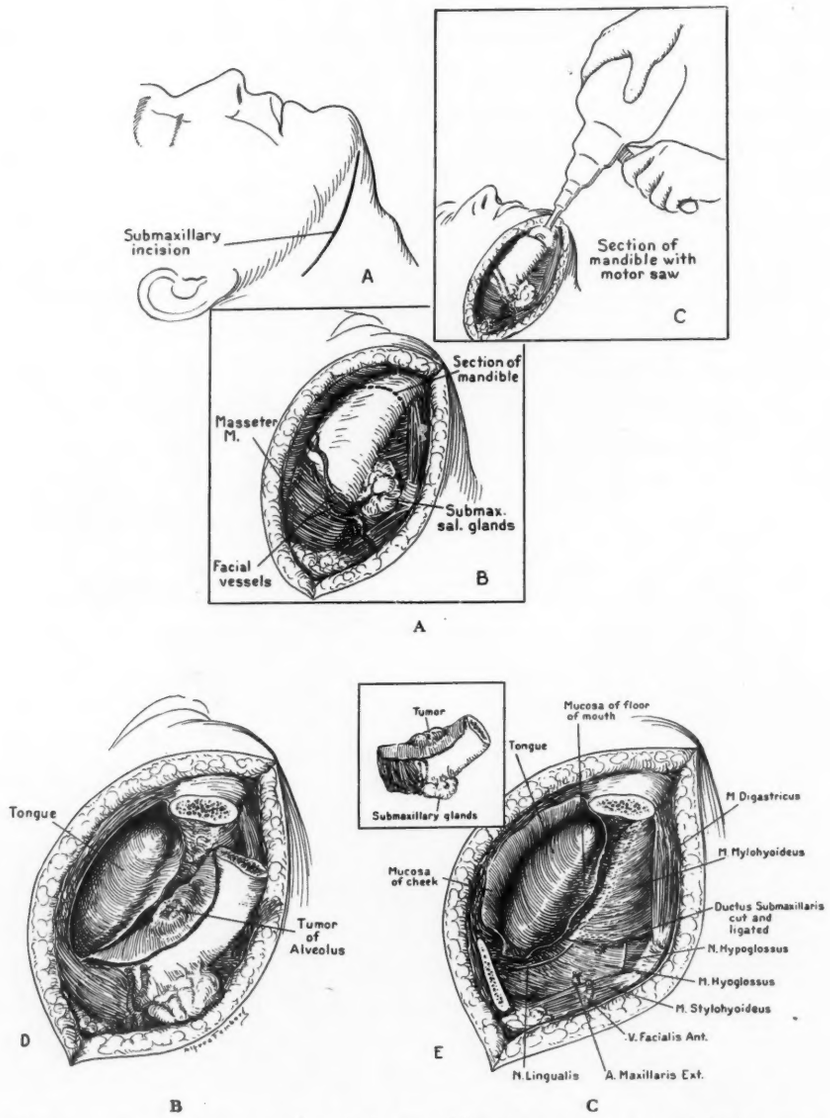
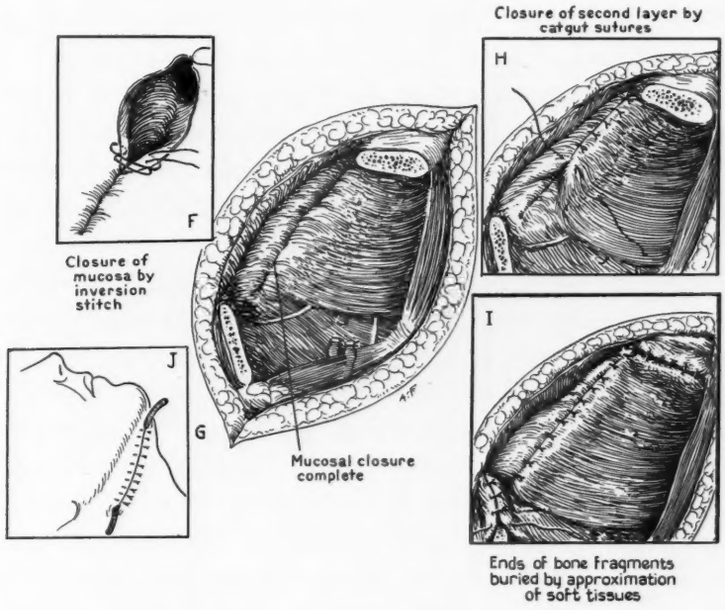


FIG. 6. A, B, C and D, *resection of the mandible through an external incision.* A, after exposure of the outer surface of the mandible through an external incision (*A* and *B*), the bone is sectioned by a motor saw (*C*). B, after section of the bone, the oral cavity is entered by an incision placed sufficiently wide of the tumor, as inspected through the open mouth. C, after incision through the soft tissues safely wide of the lesion, the bone is again sectioned near the angle by a motor saw and the bone fragment removed with the contents of the submaxillary triangle (submaxillary salivary gland and lymph-nodes). The ascending ramus of the mandible may also be sectioned by disarticulating at the temporomandibular joint. D, the operative wound is closed in layers, the mucous membrane by an inversion stitch (*F* and *G*) reinforced by a layer of muscle sutures (*H* and *I*), and finally the skin is closed with provision for subcutaneous drainage (*J*).

accompanying legends. These more extensive operations should be preceded by ligation of at least one external carotid artery.

In the upper gum this technic may be used to excise the larger



D

For descriptive legend see opposite page.

portion of the maxilla including the floor of the antrum. As far as cancer of the gums is concerned, such an operation is just as effective as total resection of the maxilla with the additional advantage that neither the uninvolved floor of the orbit nor the lateral wall of the nasal cavity is disturbed.

In the lower gum the possibilities of local surgical removal are somewhat less than in the upper gum, for unless the volume of resected bone is small, it is impossible to maintain the continuity of the mandibular arch. When a portion of this bone is removed, the deformity is extensive and the function of mastication is permanently lost. Partial or hemiresection of the mandible is sometimes indicated for persistent or recurrent cancer or for radio-osteomyelitis. If a posterior portion of the horizontal ramus is to be excised, a better cosmetic result is obtained by including the ascending ramus in the resection, disarticulating it at the temporomandibular joint (Fig. 6c); otherwise, the fragment of the ascending ramus tends to be drawn forward and upward into the oral cavity and, after healing,

constitutes a minor nuisance. When the mandible is resected for cancer, the line of incision passing through soft tissues must be determined by the probable extent of the growth. In these cases it is usually advisable to make an external incision through the skin. When the mandible is resected for radio-osteomyelitis alone, the dissection is subperiosteal through the open mouth. When resection of one mandible is contemplated and teeth are present in the uninvolved side of the mouth, arrangements should be made to wire the jaws together at the time of the operation so as to avoid distortion during the healing process. Such a precaution makes it much easier to construct prosthetic appliances.

Melanomas of the gums should always be treated surgically since this tumor is as radioresistant as normal tissue. In spite of its malignancy, melanoma does not tend to recur locally after removal with an average margin of normal tissue, so that an extremely radical excision gives no greater assurance of cure. The choice between local removal and more extensive excision of the maxilla or mandible should be based upon the size and extent of the local tumor.

Combinations of Surgery and Radiation. In selected instances, bulky infected tumors in the upper and lower gums not suitable to either radiation or surgery alone may be treated by a combination of the two, first applying radiation (*x*-ray plus interstitial radon) in what is believed to be a cancer lethal dose, followed immediately by a débridement of the heavily irradiated and condemned tissue which would otherwise undergo massive radionecrosis. The dosage technic under such a plan is extremely variable and must be individualized.

In the present series the method of treatment giving the highest percentage of success was a combination of peroral *x*-radiation supplemented by implantation of radon seeds, although in only a slightly lesser number *x*-radiation alone, perorally and externally, was successful. Cautery methods used either alone or in conjunction with radiation were successful in selected instances.

TREATMENT OF METASTASES IN CANCER OF THE GUM

Prophylactic Treatment. One of the most controversial aspects in the treatment of cervical metastases from any form of intra-oral cancer is the management of those cases in which metastases are not clinically demonstrable in the cervical lymph-nodes. There are three prevailing opinions: (1) The older surgical concept is that metastases

are present in the majority even though they cannot be palpated, and therefore block dissection should be performed in all cases. Some surgeons also advise the administration of postoperative radiation. (2) The more recent radiologic concept holds that only prophylactic radiation should be given in these cases. The dosage which has been advised varies from 1 to 2 skin erythema doses upward, although few advise the administration of dosages which have been proved lethal for demonstrable cancer. (3) The watchful-waiting policy is based upon the theory of treating cancer only where it is demonstrably present. In the latter case the surgeon assumes full responsibility for systematic follow-up with the intention of giving aggressive treatment (surgical, radiologic or combinations of the two) only when there is actual clinical evidence of metastases. A full discussion of the comparative merits of these three plans is beyond the scope of the present paper and has already been published in previous reports.[24]

The policy in the Head and Neck Clinic of the Memorial Hospital may be summarized briefly as follows: (1) Prophylactic neck dissection (an operation performed in the absence of clinically demonstrable metastases) is a tedious procedure attended by a morbidity of two to three weeks and a definite though small mortality even in experienced hands. Statistics will prove that this operation, when performed in the absence of clinically involved nodes, will be of actual value in too small a number of cases to be justified. If it is conceded that its benefit is limited to the cases of those patients who are first seen without cervical metastases in whom the primary lesion is permanently controlled and who later develop metastases, it would be useful in only one in thirty-five cases of cancer of the lip, one in eight cases of cancer of the tongue, and one in four cases of cancer of the gum. In some of these forms of cancer the operative mortality far exceeds the possible salvage. Although there is a comparatively greater risk of developing cervical metastases in cancer of the gum than in these other forms, prophylactic neck dissection is nevertheless still objectionable since it is attended by a greater risk of exposing the irradiated or surgically scarred areas within the mouth to such complications as osteomyelitis or a break-through with infection. (2) The case for prophylactic radiation is even less tenable. The critical observer realizes that the complete eradication of cancer by radiation depends upon giving a lethal dose and that no permanent benefit is to be derived from less than a lethal dose of radiation.

The lethal dose for epidermoid carcinoma has been proved to be at least 5 to 6 skin erythema doses.[18] Such a dose of radiation to the entire area of the neck in which metastases might occur is attended by marked disability and is often fatal. None of the proponents of prophylactic radiation to the neck advises giving cancer lethal doses to the entire neck. The administration of 1 to 2 skin erythema doses, a dose which has no visible effect upon the average epidermoid carcinoma, can hardly be called logical. (3) In view of the foregoing, the watchful-waiting policy seems the most reasonable from the theoretical standpoint. In brief this policy is as follows: If no metastases are clinically demonstrable at the time of admission, no treatment is given to the neck. The patient is examined at regular intervals (at least once a month for the first year). If clinical evidence of metastasis appears, aggressive treatment—either surgical or radiologic—is given, the choice depending upon the individual case. The actual merit of any plan of treatment depends upon the end results to be obtained both in the five-year end results in unselected groups and in the number and cures of proved metastases, as will be discussed further under subsequent headings.

Treatment of Clinically Demonstrable Metastases. The treatment of metastasis from the upper gum is essentially the same as in intra-oral cancer in general, since the nodes first involved are usually in the upper or subdigastric group of the internal jugular chain. In cancer of the lower gum, the mode of metastasis resembles that in cancer of the mucosa of the cheek, that is, the first involvement usually occurs to the pre- and retrovascular submaxillary nodes. In cancer of the posterior cheek or posterior lower gum, a rather unique situation occurs, that is, the first metastasis (pre- or retrovascular submaxillary node) is almost in direct contact with the primary lesion.

The treatment for metastasis from cancer of the upper gum depends mainly upon the time of the appearance of the metastases. If nodes are involved on admission, radiation is undoubtedly the most useful form of treatment. The technic for the radiation treatment of cervical metastatic cancer has been described in detail in previous reports from our clinic,[19] the most important factors being the administration of fractionated *x*-radiation through small portals (3 to 5 cm. in diameter) limited to the region of the node itself, giving a total of 5,000 to 8,000 r over a period of about three weeks (200 to 250 kv., 35 to 50 cm. T.S.D., 0.5–1.5 mm. Cu. filter), supple-

mented by the implantation of radon gold seeds either in a single dose or in fractions. In the present series, six patients with proved metastases, who were treated by radiation alone, have survived for more than five years.

In metastases from cancer of the lower gum the problem is influenced by the juxtaposition of the primary lesion and the pre- and retrovascular lymph-nodes. In peroral *x*-radiation of the primary, the beam can often be tilted so as to include both the metastases (in the pre- and retrovascular nodes) and the primary lesion. The *x*-radiation is supplemented by the implantation of radon seeds mainly in the lymph-node, thereby lessening to some extent the risk of radionecrosis and radio-osteomyelitis which are more likely to result if the seeds are implanted within the mouth. In posteriorly placed lesions of the lower gum with metastases to the submaxillary nodes, localized radio-osteomyelitis often occurs, but if the growth has been destroyed this complication can be treated conservatively until the bone sequestrates spontaneously.

For metastases which appear after healing of the primary lesion in the lower gum, the selection of treatment must be individualized, depending upon the amount of radiation scarring. Either surgery or radiation might be preferable in the individual case in an effort to favor prompt healing of the tissues. In certain complicated cases in which a metastatic node becomes attached to or invades the mandible, submaxillary dissection may be combined with resection of a portion of the mandible. In such cases the skin incision may be closed at the completion of the operation or, if large areas of skin must be removed, the wound may be left open for later plastic closure.

The present series of 113 cases is not large enough to permit any final conclusions in regard to the relative merits of radiation and surgery in the treatment of cervical metastases in cancer of the gum. Of the sixty-two patients with metastases, seven were selected as being suitable for neck dissection on the basis of apparent control of the primary lesion and the presence of early and operable metastases in the neck. All seven survived the operation but subsequently succumbed to recurrences in the neck (four cases), at the site of the primary lesion (two cases), or to systemic dissemination (one case). In the fifty-five remaining cases with lymph-node involvement, the metastases were considered inoperable or at least unsuitable for neck dissection, and treatment was by radiation alone. Six of these

patients with histologically proved metastases (aspiration biopsy) have survived for five years or more, as well as an additional three in whom the nodes were clinically positive although aspiration biopsies were omitted. The survival of at least six (about 11 per cent) for five years in comparison to no survivals by surgery is a strong indication that radiation is a more useful method than surgery in metastases from cancer of the gum. In any event, neck dissection, if used in gingival cancer, should be limited to those cases in which the primary lesion is under apparent control and the nodes occur late in the course of the disease. When nodes are present in the beginning, neck dissection can hardly be combined safely with the necessarily aggressive treatment (by either surgery or radiation) to the primary lesion.

In melanoma of the oral mucous membrane an exception might be made to the rule against prophylactic neck dissection, although it is doubtful whether the end results would be greatly influenced. As far as the Memorial Hospital cases are concerned, intra-oral melanoma invariably metastasizes so that it might be argued reasonably that a neck dissection is in order. On the other hand most of such metastases are bilateral and the systemic metastases which have also occurred in all of our cases indicate that dissemination takes place by way of the blood stream as well as by the lymph stream; therefore, neck dissection would be useless.

PROSTHETIC REPAIR OF DEFECTS OF THE MAXILLA, PALATE AND MANDIBLE

Adequate treatment of all forms of intra-oral cancer frequently necessitates a loss of the soft parts or bone and the production of both cosmetic and functional deformities. Defects of soft parts may often be repaired satisfactorily by plastic surgery; but if there has been a loss of bone of the jaws or palate, surgical repair or bone grafting is seldom practicable, and some mechanical contrivance is not only more effective but easier to apply. Dr. Andrew Ackerman, dental surgeon of the Memorial Hospital, has reported in considerable detail the forms and methods of construction of various mechanical devices for the repair of defects in the jaws and palate following treatment of cancer in the mouth.[1] In cancer of the gums, the deformities resulting from treatment are due almost entirely to loss of bone.

In the upper gum the defect, usually opening into the antrum and sometimes into the nasal cavity, produces a double disability. With large defects in this area speech is unintelligible since articulation is impaired and resonance altered. Furthermore, eating and drinking are difficult since part of the ingesta tends to enter the nasal cavity, to be expelled through the nose on swallowing. While surgical repair of these upper jaw and palatal defects is impractical, they may usually be almost perfectly remedied by prosthetic appliances so that normal function in both speech and swallowing is restored. Such devices consist mainly of a modified upper dental plate so shaped and fitted as to close tightly the opening in the palate and floor of the antrum. Firm retention is attained by a combination of several expedients, such as the usual suction cup, clasps on remaining teeth, and undercutting of the edges which fit into the defect. In the smaller defects, such prostheses can be made satisfactorily by the average dentist. When there is extensive loss of bone and soft tissue past the posterior border of the hard palate, the defects may be such as to require the services of a dentist with special training and experience in the construction of such appliances.

In the lower jaw any loss of substance involving a break in the continuity of the mandibular arch also produces both a cosmetic and functional deformity. Following the loss of the whole or of a portion of one horizontal ramus, the opposite mandible shifts toward the defective side, drawing the remaining teeth out of proper occlusion. Depending upon the amount of bone lost, and especially on whether the defect is situated anteriorly, the shape of the lower part of the face is distorted to a variable degree. When the anterior portions of both horizontal rami are lost, the normal contour of the chin is markedly altered, and the tongue, deprived of its anterior support, recedes backward and downward into the pharynx for a short distance. In addition to this cosmetic deformity the power of mastication is completely lost since the grinding of food by the molars is produced by a complicated vertical, horizontal, and lateral motion of the mandible by the combined action of two sets of temporal and pterygoid muscles. Even the simple biting action is impossible since the teeth can no longer be brought to proper occlusion. Despite these cosmetic and functional abnormalities, the loss of a portion of the mandible is compatible with perfect health, although the nature of the food must be altered.

In the repair of bone defects of the lower jaw, the interposition of a bone or cartilage graft from a rib or other bone is sometimes advised. Although such an operation is technically feasible if done immediately following partial resection of the mandible, it can seldom if ever be applied in cancer of the gums. Such bone or cartilage grafts, to be successful, must be embedded in healthy vascular soft parts in a sterile field. In surgical resection of the average gum cancer, the intra-oral wound cannot be sutured, and in any case would be grossly contaminated by infection. Following radiation the decreased vascularity of the tissues in the healed state would make the success of the bone grafting doubtful. Furthermore, in most cases after the treatment of cancer, the possibility of recurrence would make it prudent to wait for a year or two before any grafting were attempted, and by that time the scarring and contracture are so firm as to make restoration of the normal contour impossible, even if a sufficient thickness of soft tissue were present in which bone grafts might be embedded.

In the most marked deformities following partial loss of the mandible, there is no method of complete restoration. In certain instances, however, in which there is minimal scarring and not too great a loss of bone and soft tissue, Ackerman has succeeded in markedly improving both the appearance and the function by ingenious hinged devices attached to an upper denture. Although the ability to masticate has seldom been restored, such devices contribute a great deal to the patient's comfort and appearance.

COMPLICATIONS

Radionecrosis and Osteomyelitis. As has been previously mentioned, the gum consists of a thin layer of soft tissue about 2 to 3 mm. in thickness overlying bone. The blood supply of the gum is entirely peripheral, coming from the adjacent cheek, palate or floor of the mouth. The thinness of the gum and the lack of a blood supply from its base make this structure particularly susceptible to local radionecrosis following cancer lethal radiation. Radiation in such dosage, which also reaches the underlying bone, is sufficient to destroy the finer osseous circulation, so that when bone is exposed by radionecrosis of the overlying gum, radio-osteomyelitis is almost inevitable. It is only by appreciation of these facts and by meticulous attention to the details of radiation technic that such complications can be avoided or their severity diminished. The most important

precaution is the limitation of the portal or external radiation to the smallest efficient diameter and the accurate centering of the radiation beam.

In the present series there was radionecrosis of soft tissue in about 50 per cent of the cases, and at least half of these subsequently developed radio-osteomyelitis with some loss of bone. When superficial radionecrosis occurs with exposure of the underlying bone, the best treatment is conservative, combatting the sepsis with frequent irrigations and applying oxygenic preparations (zinc peroxide) over a period of weeks or even months until the bone finally sequestrates. The exposed fragment of bone may be manipulated gently from time to time in an attempt to hasten its separation. If local sepsis and pain attendant upon the osteomyelitis are particularly severe, partial resection of the bone in either the upper or lower jaws may be indicated. In such cases the line of resection should be through viable bone, which is possible only if the beam of external radiation has been limited in extent. When wide beams of 8 to 10 cm. in diameter are used, the radio-osteomyelitis usually progresses through the entire mandible or maxilla. The morbidity is long, and the complications often fatal.

Dental Complications. The extent to which the presence of teeth in either the upper or lower jaws is an obstacle to the administration of both surgical and radiologic treatment has already been mentioned. The complications which are likely to follow the extraction of teeth have also been described. When sound teeth are permitted to remain within the field of cancer lethal radiation, dental complications are inevitable. When the teeth and adjacent alveolar processes are irradiated in cancer lethal doses, the gums retract and the teeth are devitalized, probably as the result of a devitalization of the peridental membrane and the destruction of the apical circulation. Over a period of several months to a year, such teeth lose their normal gloss and assume a chalky appearance. Numerous cavities develop, not only on the occlusal surface but near the gum margins. The tooth structure crumbles away, and in some cases the entire exposed portion of the tooth disappears down to the gum margin, leaving a decalcified exposed root.

When teeth are extracted before treatment is begun, the granulation tissue in the tooth sockets tends to disappear under heavy irradiation, leaving avascular bone exposed. When teeth are extracted at an interval after heavy irradiation, the tooth sockets

may bleed very little, and granulation tissue may fail to develop. Osteomyelitis then occurs, beginning in the exposed bone. There is no way of eliminating these dental complications, but their extent and severity can be markedly reduced by meticulous attention to the details of radiation therapy and hygienic care.

Pain. As has been mentioned previously, pain is not a prominent early symptom in cancer of the gums, due mainly to the fact that these tissues are poorly supplied with nerves. Pain seldom becomes a marked symptom in cancer of the gums except after invasion and sepsis of the bone or of the soft tissues of the cheek, the floor of the mouth or the palate.

With osteomyelitis of the maxilla or mandible, it is mainly the superior and inferior dental nerves which are affected, and in these cases neurolysis of the second and third divisions of the fifth cranial nerves by alcohol may effect complete relief from pain provided that complications do not extend into the areas supplied by other nerves, such as the ninth or the upper cervical branches.

Hemorrhage. Following erosion by disease or radionecrosis, hemorrhage occurred as a complication in over 20 per cent of the present series and was the cause of death in six cases. It occurred most frequently in growths of the upper gum. The blood supply to the upper jaw is mainly from the internal maxillary artery, the larger branches of which lie rather deeply in the pterygotemporal fossa so that serious hemorrhage rarely occurs except when there is deep erosion following radionecrosis in this area. The blood supply of the lower jaw and adjacent soft parts is from the inferior dental, the external maxillary and the lingual branches of the external carotid arteries. Serious hemorrhage does not occur from the inferior dental artery which is relatively small in size. Deep erosion or slough in the floor of the mouth or in the gingivobuccal gutter may erode either the external maxillary or the lingual artery or both, and hemorrhage may be severe enough to be fatal immediately.

When bleeding occurs from any one of these vessels, the immediate treatment is by local tamponage with gauze packing and digital pressure, followed as soon as possible by ligation of the external carotid artery. Since in most cases the healing of the wound in the mouth may not take place for several months, the occlusion of the artery should be permanent, either by section of the vessel by double ligatures or, preferably, by the use of a metal ligature. When

bleeding occurs from the lower jaw, the ligature on the external carotid must be placed below the origin of the lingual artery.

PROGNOSIS

In the medical literature where specific reference is made to the subject, cancer of the gum is usually reported to have a bad prognosis.[11,14] At the Memorial Hospital the chance of cure in this group of tumors is slightly better than that in cancer of the tongue, floor of the mouth, or tonsil, and about the same as in cancer of the cheek. The factors influencing the chance of cure are given in Table III, the most important of which will be discussed separately.

Age. Although in most forms of intra-oral cancer the chance of cure is better in the younger age groups, an analysis of the present series gives little evidence in this regard. Although two of four patients (50%) under the age of forty were cured, but the number is too small to permit of any definite conclusions.

Sex. As in all forms of intra-oral cancer which we have studied in our clinic, an analysis of the present series indicates that the chance of cure of cancer of the gums is better in females (50 per cent) than in males (23 per cent). It is probable that this difference is due mainly to the fact that all anatomic and histologic forms of cancer are more radiosensitive in the female than are their counterparts in the male.

Position of the Growth. Although one might expect a difference in the cure rate between cancers of the upper and lower gum and between lesions near the symphysis and those situated posteriorly near the soft palate, there appears to be no significant variation in this regard.

Size of the Primary Growth. As might be expected, the size of the primary lesion on admission is one of the most important factors in the prognosis. When the growths were less than 2 cm. in diameter, the cure rate was 50 per cent, as compared to 13 per cent in those over 4 cm. The average size of the growths in all cases was 3.3 cm., in the fatal cases 3.5 cm., and in the cured cases 2.9 cm.

Metastases. In gingival growths, as in all forms of cancer, the occurrence of metastases is the most important factor in prognosis. Among patients with no metastases at any time, the five-year cure rate was almost 50 per cent, as compared to 11 per cent when metastases were present some time during the course of the disease. There were no survivals among the thirty-eight patients with metastases on

TABLE III

FACTORS INFLUENCING THE PROGNOSIS IN 105 DETERMINATE CASES OF CANCER OF THE GUM AT THE MEMORIAL HOSPITAL

	Total Cases	Five-year Cures	Five-year Cure Rate
Age			
Under 40	4	2	50
40 to 49	10	2	20
50 to 59	21	7	30
60 and over	67	15	22
Not stated	3	1	
Sex			
Male	85	19	22
Female	20	8	40
Position of the growth			
Right	44	14	32
Left	56	12	21
Both	2	0	0
Midline	3	1	33
Upper	47	12	25
Lower	57	15	26
Both	1	0	0
Size of lesion			
0 to 1.9 cm	8	3	38
2 to 2.9 cm	25	7	28
3 to 3.9 cm	16	5	31
4 cm. or over	35	6	17
Size not stated or scar present	21	6	29
Metastases			
On admission	38	0	0
None on admission	67	27	40
Cervical involvement later	17	6	35
Distant metastases later	7	0	0
Metastases sometime during course	62	6	10
No metastases at any time	43	21	49
Histopathology			
Squamous carcinoma grade I	26	12	46
Squamous carcinoma grade II	62	11	18
Squamous carcinoma grade III	1	1	100
Adenocarcinoma	5	2	40
Spindle cell carcinoma	1	0	0
Lymphoepithelioma	1	1	100
Lymphosarcoma	1	0	0
Melanoma	4	0	0
No disease at primary site on admission	4	0	0

admission. These figures might suggest that cancer of the gum is unusually malignant once it has metastasized, but when compared with other forms of intra-oral cancer (Table IV), it will be seen that the cure rates in cancer of the tongue, the tonsil, and the cheek with metastases are at about the same level, while in cancer of the floor of the mouth, the lip, and the nasopharynx with metastases, the cure rates are somewhat higher.

Histopathology. The cure rate in cases of squamous carcinoma grade I was 48 per cent in the present series, almost twice the average and about two and one-half times that of the most frequent tumor, squamous carcinoma grade II (18 per cent). The total number of adenocarcinomas is too small to be of significance, but two of the five survived. Melanoma of the oral mucous membranes is always serious and is seldom cured. All four patients of the present series succumbed to widely disseminated disease.

END RESULTS

We have been unable to find any specific figures for five-year end results in cancer of the gums which are well-attested, that is, the few published reports are not based upon consecutive, unselected cases, all histologically proved, and in most instances too large a percentage of the patients are untraced. In some reports the data are inconclusive because of the inclusion of gingival tumors with other forms of cancer, chiefly of the antrum. The closest approximation to accurate end result figures is found in the reports of Edling[5] and Gaini,[8] both of whom used radiation as the main form of treatment. In Edling's series the diagnosis was not verified histologically in one-third of the cases. He reports three of twenty-six patients (11 per cent) alive and well, but admits that in one of these the presence of cancer was not confirmed by biopsy. Gaini[8] attempts to give five-year end results in a series of fifty-three cases. His figures are rather confusing, but the lack of adequate follow-up is apparent since in all his calculations at various periods, about one-third of the patients are untraced. He reports that at the end of five years, six patients were alive and well (12 per cent). The five-year cure rates in both of these series would probably be higher if there had been accurate follow-up and a correction for those patients who died of other causes without recurrence of cancer.

The net end results in the present series of cases, all histologically proved, are given in Table V. As has been mentioned, this series is

TABLE IV

CURE RATES IN METASTASES FROM INTRA-ORAL AND PHARYNGEAL CANCER AT THE MEMORIAL HOSPITAL

	Per Cent
Gum	11
Tonsil	10
Cheek	11
Tongue	12
Nasopharynx	20
Floor of mouth	22
Lip	27

made up of all patients with gingival cancer who applied at the Memorial Hospital during the years 1929 to 1935, inclusive, and were able (ambulatory) and willing to return for treatment or palliation. None was excluded because of an advanced stage of the disease. Before calculating net end results, those patients were excluded who died of other causes or who were lost track of after a year's freedom from disease. In the entire group the cure rate is

TABLE V

MEMORIAL HOSPITAL FIVE-YEAR END RESULTS IN CANCER OF THE GUMS
1929 to 1935, Inclusive

This series consists of all patients with histologically proved cancer of the gums, both early and advanced, admitted during the specified period. Only those patients are excluded who, for any reason, were unable to return for treatment, palliation and observation in the out-patient department or who were lost track of within the first month after no more than one or two visits (clinic shoppers).

Total number of cases		113
Indeterminate group:		
Dead as a result of other causes and without recurrence	6	
Lost track of without recurrence	2	
Total number of indeterminate results		8
Determinate group:		
Total number minus those of indeterminate group		105
Failures:		
Dead as a result of cancer	72	
Lost track of with disease (probably dead)	5	
Living with recurrence	1	
Total number of failures in treatment		78
Successful results:		
Free from disease after five years or more		27
Five-year end results:		
Successful results divided by determinate group ($^{27}/_{105}$)		25.7%

25.7 per cent. Among the cases of carcinoma alone, excluding melanoma, the cure rate is 27 per cent.

SUMMARY

A series of 113 consecutive cases of cancer of the gums (gingivae) is analyzed from the standpoint of etiology, clinical course, treatment and end results. Treatment methods by radiation, surgery, and combinations of the two, with their attendant complications, are described in detail.

The net cure rate in the series, calculated in 105 determinate cases, is 25.7 per cent.

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AUTHOR INDEX TO VOLUME LIV

Albee, Fred H., 605
Andresen, Albert F. R., 339
Andrews, Albert H., Jr., 193
Anton, Joseph I., 446

Bain, C. Grant, 388
Barbano, Alfred J., 731
Beck, Claude S., 273
Berens, Conrad, 346
Berry, Frank B., 280
Betts, Reeve H., 82
Bisgard, J. Dewey, 317
Blades, Brian, 139
Blalock, Alfred, 149
Bloom, Oscar H., 443
Bobrow, Morris L., 682
Bodon, George T., 744
Bogart, Donald, 346
Bosworth, Boardman M., 502
Bowen, Arthur, 508
Briscoe, Clarence C., 634
Browne, Harold R., 466
Brunn, Harold, 179
Brunstein, I. A., 362
Buda, Alfred M., 384
Burnett, W. Emory, 99
Butcher, Thomas Peck, 755
Butler, Ethan Flagg, 215

Cave, Edwin F., 371
Caylor, Harold D., 760
Clute, Howard M., 151
Cohn, Bernard N. E., 741
Collins, J. Lloyd, 701
Colonna, Paul C., 609
Cooper, David A., 224
Copleman, Benjamin, 39
Cotton, Bert H., 173
Crossman, Lyman W., 395

DeVito, Michael P., 716
Dimmler, Charles L., 29

Eckerson, Edwin Breck, 487
Ellingson, Oren, 484
Elliott, Clinton A., 614
Erich, John B., 435

Falk, Henry C., 674
Faxon, Henry H., 114
Feldheym, Jean Spencer, 417
Fleming, Richard M., 457
Furniss, H. D., 510

Gamble, H. A., 727
Garlock, John H., 262
Golden, Benj. I., 407
Goldman, Alfred, 179
Goodman, Henry I., 472
Gordon, Charles A., 525
Gray, Howard K., 252
Green, Raymond, 659

Hamilton, G. Johnson, 479
Hamilton, Joseph E., 668
Hanley, Bernard J., 403
Harris, Franklin I., 417
Hart, Deryl, 295
Hicken, N. Frederick, 723
Hinton, J. William, 431
Holinger, Paul, 193
Holmes, John F., 326
Hooker, Donald H., 412
Hurley, Gerard A. P., 228

Jackson, Chevalier, 211
Jackson, Chevalier L., 211
Janes, Robert M., 127
Jensen, D. Rees, 377

Kempner, Ivan, 674
Kidder, James H., 395
Kimball, J. LeRoy, 723
Klepser, Roy G., 716
Koskoff, Yale D., 653

Laird, George J., 729
Lam, Conrad R., 412
Lanman, Thomas H., 29
Latimer, Earl O., 424
Lawrence, Knowles B., 151
Levitin, Joseph, 494
Luck, J. Vernon, 505
Lyday, Russell O., 678
Lynch, Jerome M., 479

Macey, Harry B., 643
Macmanus, Joseph E., 721
Maier, Herbert C., 68
Marks, Joseph H., 306
Martin, Hayes, 765
Martin, J. E., Jr., 407
Merideth, Clyde O., Jr., 755
Muller, George P., 35

Neuhof, Harold, 39
New, Gordon B., 435
Niemeyer, Arnold C., 18

O'Donoghue, Arch F., 758
Olin, Harry A., 614
Ottenheimer, Edward J., 759
Overholt, Richard H., 1, 161

Packer, Bernard D., 737
Panoff, Charles E., 446
Pohle, Ernst A., 490
Poppen, James L., 439
Purcell, Frank H., 589

Rebbeck, E. W., 691
Rezek, Phillip R., 457
Riggins, H. McLeod, 50
Roberts, J. E. H., 289
Rosenthal, Alexander H., 525, 639
Rulison, Elbert T., Jr., 499

Saypol, George M., 431
Schaefer, Robert L., 589
Schrager, V. L., 629
Schultz, Philip E., 4
Scott, G. D., 391
Scott, Irvin H., 391
Sharpe, Walter E., Jr., 733
Sharpe, Wendell S., 252
Spiegel, Milton B., 446
Stalker, Leonard K., 499
Staples, O. Sherwin, 371
Stern, Elias Lincoln, 711
Stickler, W. Hugh, 511

Tabb, J. Lloyd, 737
Toulson, W. Houston, 753
Tubbs, O. S., 289

Vayo, Perry G., 744
Veal, J. Ross, 716
Vinton, Kenneth W., 511

Wall, Norman M., 653
Warbasse, James P., Jr., 648
Weinstein, Jacob J., 701
Weintrob, David I., 747
Weintrob, Morris, 747
Welton, Thurston S., 484
White, Charles Stanley, 701
White, John D., 499
Wiggin, Sidney Cushing, 4
Wilson, Robert A., 634
Woodruff, Warriner, 236

SUBJECT INDEX TO VOLUME LIV

(Bo. B.) = Bookshelf Browsing; (E.) = Editorial

Abdomen, heterotaxy of, 446
Abscess
  pulmonary, management of, 82
  subphrenic, logical approach to, 114
Adenoma
  bronchial, 179
  of Langerhans' islet of pancreas, 744
Adenomyoma of stomach, 395
Air bubbles in intravenous apparatus, 759
Analgesia, obstetrical, 403
Anesthesia, in thoracic surgery, 4
Appendectomy with Furniss clamp, 508
Appendicitis, acute, rectus incision in, 388
Appendix
  argentaffine tumors of, 424
  stump of, and prophylaxis, 629
Approach, logical, to subphrenic abscess, 114
Aspects, biochemical, of preoperative and postoperative treatment, 653
Atelectasis, pulmonary, postoperative, 18
Avulsion of distal tendon of biceps brachii, 733
Axilla, hidrosadenitis suppurativa of, 643

Biceps brachii, avulsion of tendon of, 733
Bile duct, obstruction of, by piece of liver, 723
Biographies, Park and Welch (E.), 588
Blood
  autotransfused, in puerperal sepsis, 691
  vessels, migration of projectiles in, 729
Bodies
  foreign, as a cause of fistula-in-ano, 384
    in lung, 211
Bone
  drilling in chronic ulcers, 605
  saw and drill, electric, 505
Book Reviews:
  Abdominal Surgery of Infancy and Childhood (Ladd and Gross), 520
  Operative Surgery (Bancroft), 761
Braun perineal scissors, modified, 760
Breast, carcinoma of, and sterilization of ovaries, 490
Bronchiectasis, morbidity and mortality in, 50
Brunner's glands, heterotopia of, producing pyloric obstruction, 395
Burn scar, sarcoma in, 457

Cage, thoracic, tumors of, 127
Cancer of the gums (gingivae), 765
Carcinoma
  bronchogenic, of lung, 614
  of breast, sterilization of ovaries and metastases in, 490
  of lung as a surgical problem, 161
  of stomach, 431
  of thoracic esophagus, 262
Carnero, fish parasite of man and other mammals (Bo.B.), 511
Cartilage, rib, slipping, 326
Cataract, acquired, operations for and complications, 346
Cecum, mobile, with left hydrocele, 753
Cervix, pessary in, and pregnancy, 484
Cesarean section, the modern operation, 525
Chest
  deformities of, resulting from thoracic disease and operation, 317
Chest
  injuries to, 280
  war wounds of, 289
Children
  empyema in, 29
  painful hip in, 609
Chondro-epiphysitis, juvenile, 589
Clamp, Furniss, for appendectomy, 508
Complications
  affecting segments of eyeball, 346
  immediate, in operations for cataract, 346
Contracture, Dupuytren's, procedure for, 711
Control of postpartum hemorrhage, 634
Cranium, neoplastic lesions of, 439
Cysts, pulmonary, 68

Deferment and medical students (E.), 587
Derangement of knee caused by congenital discoid meniscus, 371
Diagnosis
  differential, of painful hip, 609
    of primary and metastatic malignancy of lung, 173
  in intra-abdominal pregnancy, 747
Diaphragm
  hernia of, 306
  paralysis of, in lung tuberculosis, 228
Discoid meniscus, congenital, and derangement of knee, 371
Disease
  Garré's, 377
  pulmonary, help in control of (E.), 1
  thoracic, and deformities of chest and spine, 317
Disorders, mental, and hyperthyroidism, 499
Diverticulum, Meckel's, rupture of, 727
Dog surgery, 755
Doyen tumor screw, Furniss modification of, 510
Drainage, gastric, postoperative, 648
Drilling, of bone, in chronic ulcers, 605
Duodenum, congenital obstruction of, 678
Dupuytren's contracture, operative procedure for, 711

Elimination of air bubbles from intravenous apparatus, 759
Emergency control of postpartum hemorrhage, 634
Empyema
  acute, in children, 29
  chronic, etiology of, 35
  encapsulated, 39
Esophagus
  benign lesions at end of, 252
  thoracic, treatment of carcinoma of, 262
Etiology of chronic empyema, 35
Evisceration, postoperative, 682
Exhaustion, leukocyte, in intestinal obstruction, 417
Exstrophy of rectal mucosa, 479
Eyeball, segments of, complications affecting, 346

Fibrillation, ventricular, during operation, 273
Fibromyomas, extrauterine, 391
Fistula, bronchopleural, recognition and management of, 236
Fistula-in-ano and the rôle of foreign bodies, 384
Food, oral administration of, to surgical patients, 407
Fractures of toes, plaster slipper for, 721
Frequency of intrathoracic tumors, 139
Furniss clamp, modified, for appendectomy, 508

Garré's disease, 377
Glands, Brunner's, heterotopia of, 395
Goiter, intrathoracic, 151
Grafting, skin, preparation of wounds for, 716
Grafts, cartilage, costal, method to prevent warping of, 435
Gums, cancer of, 765

Healing of operative wound in syphilitic women, 674
Hemorrhage
  postpartum, control of, 634
  pulmonary, treatment of, in tuberculous patient, 224
Hernia, diaphragmatic, 306
Heterotaxy, abdominal, 446
Heterotopia of Brunner's glands, 395
Hidrosadenitis suppurativa, 643
Hip, painful, in childhood, 609
Hydrocele, left, mobile cecum and, 753
Hyperthyroidism and mental disorders, 499
Hypothyroidism and chondro-epiphysitis, 589

Implantation, intracranial, of sulfanilamide, 653
Incision, right, lateral, rectus, in appendicitis, 388
Infection, pelvic, treatment of, 639
Injuries
  chest, treatment of, 280
  tendon, 412
Intestine, motility of, after gastric surgery, 648
Intussusception, iliocolic, diagnosis by *x*-ray for, 494
Iontophoresis of choline compound for pelvic infection, 639
Irradiation, ultraviolet, of autotransfused blood in puerperal sepsis, 691

Knee, derangement of, and discoid meniscus, 371

Lactation, suppression of, by stilbestrol, 443
Langerhans' islet of pancreas, adenoma of, 744
Laparotomy, exploratory, versus peritoneoscopy, 502
Lesions
  benign, at lower end of esophagus, 252
  neoplastic, destructive, of cranium, 439
Leukocyte exhaustion in intestinal obstruction, 417
Liver, piece of, obstruction of bile duct by, 723
Lung
  carcinoma of, 161, 614
  foreign bodies in, 211
  malignancy of, 173
  tuberculosis of, and paralysis of diaphragm, 228

Malignancy, primary and metastatic, of lung, 173
Management
  of bronchopleural fistula, 236
  of empyema in children, 29
  of mediastinitis, 99
  of pulmonary abscess, 82
Marjolin's ulcer, 466
Meckel's diverticulum, rupture of, 727
Media, contrast, *x*-ray diagnosis without, 494
Mediastinitis, recognition and management of, 99
Medical students, deans and deferment (E.), 587
Meningitis, postoperative, prevention of, with sulfanilamide, 653
Methylene blue as indicator for oral administration of food, 407
Migration of projectiles in blood vessels, 729
Morbidity and mortality in peritoneoscopy and exploratory laparotomy, 502
Mortality in bronchiectasis, 50
Motility, gastrointestinal, re-establishment of, after surgery, 648
Mucosa, rectal, exstrophy of, 479
Murphy drip, modifications of, 759
Myasthenia gravis and tumors of thymic region, 149

Obstetrics, analgesia in, 403
Obstruction
  bronchial, signs, symptoms and diagnosis of, 193
  duodenal, congenital, 678
  intestinal, leukocyte exhaustion in, 417
  of bile duct by detached piece of liver, 723
  pyloric, and heterotopia of Brunner's glands, 395
Ointment, sulfanilamide-allantoin, for skin grafting, 716
Operation
  cardiac standstill and ventricular fibrillation during, 273
  cesarean, 525
  evisceration after, 682
  for Dupuytren's contracture, 711
  gastric, intestinal motility after, 648
Osteomyelitis
  pyogenic, recurring, 741
  sclerosing, chronic, 377
Ovary, pregnancy in, 487

Pancreas, adenoma of Langerhans' islet of, 744
Paralysis of diaphragm in treatment of lung tuberculosis, 228
Parasite, fish, of man (Bo.B.), 511
Park biography (E.), 588
Patients
  private, obstetrical analgesia in, 403
  surgical, oral administration of food to, 407
  tuberculous, pulmonary hemorrhage in, 224
Pelvis, infection of, 639
Peritoneoscopy, 668
  versus exploratory laparotomy, 502
Pessary, intrauterine, and pregnancy, 484
Phillip's recessed head screw, 758
Plasma-saline mixture for shock, 701
Plaster slipper for toe fractures, 721
Pregnancy
  and delivery with pessary in cervix, 484
  intra-abdominal, 747
  ovarian, 487
Prevention
  of discomfort and disability in treatment of varicose veins, 362
  of meningitis, postoperative, with sulfanilamide, 653
Problem, surgical or medical, peptic ulcer as a (E.), 339
Projectiles in blood vessels, migration of, 729
Prophylaxis for appendiceal stump, 629
Pseudofracture of tibia, 737

Rectum, exstrophy of mucosa of, 479
Region, thymic, tumors of, 149
Resuscitation for cardiac standstill and ventricular fibrillation during operation, 273
Rib cartilage, slipping, 326
Riedel's thyroiditis, 472
Roentgen
  rays, sterilization of ovaries by, 490
  study of lung carcinoma, 614
Rupture, subcutaneous, of Meckel's diverticulum, 727

Sarcoma in old burn scar, 457
Saw and drill, bone, electric, 505
Scar, old burn, sarcoma in, 457
Scissors, perineal, Braun, 760

Screw
Phillip's recessed, 758
tumor, Doyen, 510
Sepsis
puerperal, autotransfused blood for, 691
wound, in thoracic surgery, 295
Shell wounds, multiple, 731
Shock, surgical and traumatic, with plasma-saline mixture, 701
Site of intrathoracic tumors, 139
Skin grafting, preparation of wounds for, 716
Slipper, plaster, for toe fractures, 721
Spine, deformities of, resulting from thoracic disease and operation, 317
Standstill, cardiac, during operation, 273
Sterilization of ovaries by roentgen rays, 490
Stilbestrol, suppression of lactation by, 443
Stomach
adenomyoma of, 395
carcinoma of, 431
Stump, appendiceal, and prophylaxis, 629
Sulfanilamide
and sulfanilamide-allantoin ointment in skin grafting, 716
intracranial implantation of, 653
Suppression of lactation by stilbestrol, 443
Surgery
thoracic, anesthetic procedures in, 4
wound sepsis in, 295

Technic, surgical, for removal of neoplastic lesions of cranium, 439
Tendon
distal, avulsion of, 733
injuries to, 412
Thorax, anesthesia in surgery of, 4
Thyroiditis, Riedel's, 472
Tibia, pseudofracture of, 737
Toes, plaster slipper for fractures of, 721
Treatment
of injuries to chest, 280
of lung tuberculosis and paralysis of diaphragm, 228
of pelvic infection, 639
of pulmonary hemorrhage, 224
Treatment, of shock, with plasma-saline mixture, 701
preoperative and postoperative, biochemical aspects of, 653
surgical, of axillary hidrosadenitis suppurativa, 643
of carcinoma of thoracic esophagus, 262
of pulmonary tuberculosis, 215
Tuberculosis
of lungs and paralysis of diaphragm, 228
pulmonary, developments in surgical treatment of, 215
Tumor screw, Doyen, 510
Tumors
argentaffine, malignant, of appendix, 424
intrathoracic, frequency and site of, 139
of thoracic cage, 127
of thymic region and myasthenia gravis, 149

Ulcer, Marjolin's, 466
Ulcers
chronic, and bone drilling, 605
peptic, intractable (E.), 339
Uterus, fibromyomas outside of, 391

Varicose veins, treatment of, 362

Warping of cartilage grafts, method to prevent, 435
War wounds of chest, 289
Welch biography (E.), 588
Women, syphilitic, healing of wound in, 674
Wound
operative, healing of, 674
sepsis in thoracic surgery, 295
Wounds
shell, multiple, 731
superficial, preparation of, for skin grafting, with sulfanilamide-allantoin ointment, 716

X-ray, diagnosis by, of iliocolic intussusception, 494

The American Journal of Surgery

PUBLISHED MONTHLY BY THE AMERICAN JOURNAL OF SURGERY, INC.
49 WEST 45TH STREET, NEW YORK, N. Y.

Editor: THURSTON SCOTT WELTON, M.D., NEW YORK

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NEW SERIES, VOLUME LIV

OCTOBER TO DECEMBER

1941

THE AMERICAN JOURNAL OF SURGERY · INC · PUBLISHERS
NEW YORK MCMXLI

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Printed in the United States of America

CONTENTS OF NEW SERIES, VOLUME LIV

ORIGINAL ARTICLES

Anesthetic Procedures in Thoracic Surgery	*Sidney Cushing Wiggin* *Philip E. Schultz*	4
Postoperative Pulmonary Atelectasis	*Arnold C. Niemeyer*	18
Management of Acute Empyema in Children	*Thomas H. Lanman* *Charles L. Dimmler*	29
Etiology of Chronic Empyema	*George P. Muller*	35
Encapsulated Empyema	*Harold Neuhof* *Benjamin Copleman*	39
Bronchiectasis: Morbidity and Mortality of Medically Treated Patients	*H. McLeod Riggings*	50
Pulmonary Cysts	*Herbert C. Maier*	68
Principles in the Management of Pulmonary Abscess	*Reeve H. Betts*	82
Recognition and Management of Mediastinitis	*W. Emory Burnett*	99
Logical Approach to Subphrenic Abscess	*Henry H. Faxon*	114
Tumors of the Thoracic Cage	*Robert M. Janes*	127
Relative Frequency and Site of Predilection of Intrathoracic Tumors	*Brian Blades*	139
Tumors of the Thymic Region and Myasthenia Gravis	*Alfred Blalock*	149
Intrathoracic Goiter	*Howard M. Clute* *Knowles B. Lawrence*	151
Carcinoma of the Lung as a Surgical Problem	*Richard H. Overholt*	161
Differential Diagnosis of Primary and Metastatic Malignancy of the Lung	*Bert H. Cotton*	173
Bronchial Adenoma	*Harold Brunn* *Alfred Goldman*	179
Bronchial Obstruction: Signs, Symptoms and Diagnosis	*Paul Holinger* *Albert H. Andrews, Jr.*	193
Foreign Bodies in the Lung	*Chevalier Jackson* *Chevalier L. Jackson*	211
Recent Developments in Surgical Treatment of Pulmonary Tuberculosis	*Ethan Flagg Butler*	215
Emergency Treatment of Pulmonary Hemorrhage in the Tuberculous Patient	*David A. Cooper*	224
Temporary versus Permanent Paralysis of the Diaphragm in the Treatment of Tuberculosis of the Lungs	*Gerard A. P. Hurley*	228
Recognition and Management of Bronchopleural Fistula	*Warriner Woodruff*	236
Benign Lesions at the Lower End of the Esophagus	*Howard K. Gray* *Wendell S. Sharpe*	252
Present Status of the Surgical Treatment of Carcinoma of the Thoracic Esophagus	*John H. Garlock*	262

Resuscitation for Cardiac Standstill and Ventricular Fibrillation Occurring during Operation	*Claude S. Beck*	273
Treatment of Injuries to the Chest	*Frank B. Berry*	280
Recent Experience with War Wounds of the Chest	*J. E. H. Roberts*, *O. S. Tubbs*	289
Problem of Wound Sepsis in Thoracic Surgery	*Deryl Hart*	295
Diaphragmatic Hernia	*Joseph H. Marks*	306
Deformities of the Chest and Spine Resulting from Thoracic Disease and Operation: Their Prevention	*J. Dewey Bisgard*	317
Slipping Rib Cartilage. With Report of Cases	*John F. Holmes*	326
Immediate Complications of Operations for Acquired Cataract. Certain Complications Affecting the Anterior and Posterior Segments of the Eyeball	*Conrad Berens*, *Donald Bogart*	346
Prevention of Discomfort and Disability in the Treatment of Varicose Veins	*I. A. Brunstein*	362
Congenital Discoid Meniscus. A Cause of Internal Derangement of the Knee	*Edwin F. Cave*, *O. Sherwin Staples*	371
Chronic Sclerosing Osteomyelitis: Garré	*D. Rees Jensen*	377
General Considerations of Fistula-In-Ano. The Rôle of Foreign Bodies as Causative Factors	*Alfred M. Buda*	384
Right Lateral Rectus Incision in Acute Appendicitis	*C. Grant Bain*	388
Extrauterine Fibromyomas	*G. D. Scott*, *Irvin H. Scott*	391
Adenomyoma of the Stomach. Heterotopia of Brunner's Glands Producing Pyloric Obstruction. Case Report	*Lyman W. Crossman*, *James H. Kidder*	395
Obstetrical Analgesia in Private Patients	*Bernard J. Hanley*	403
Methylene Blue as an Indicator for the Oral Administration of Food to the Surgical Patient	*Benj. I. Golden*, *J. E. Martin, Jr.*	407
Tendon Injuries. A Study of One Hundred and Sixteen Cases	*Donald H. Hooker*, *Conrad R. Lam*	412
Leukocyte Exhaustion in Intestinal Obstruction	*Franklin I. Harris*, *Captain Jean Spencer Feldheym*	417
Malignant Argentaffine Tumors of the Appendix	*Earl O. Latimer*	424
Statistical Review of Carcinoma of the Stomach	*George M. Saypol*, *J. William Hinton*	431
Method to Prevent Fresh Costal Cartilage Grafts from Warping	*Gordon B. New*, *John B. Erich*	435
Surgical Technic for Removal of Solitary Destructive Neoplastic Lesions of the Cranium	*James L. Poppen*	439
Suppression of Lactation by Stilbestrol	*Oscar H. Bloom*	443
Segmental Abdominal Heterotaxy. Situs Inversus Viscerum Abdominis Partialis	*Joseph I. Anton*, *Charles E. Panoff*, *Milton B. Spiegel*	446
Sarcoma Developing in an Old Burn Scar	*Richard M. Fleming*, *Philip R. Rezek*	457

Marjolin's Ulcer. Report of a Case	*Harold R. Browne*	466
Riedel's Thyroiditis. A Review and Report of Two Cases	*Henry I. Goodman*	472
Exstrophy of Rectal Mucosa	*Jerome M. Lynch*, *G. Johnson Hamilton*	479
Pregnancy and Delivery with an Intrauterine Pessary in the Cervix	*Thurston S. Welton*, *Oren Ellingson*	484
Primary Ovarian Pregnancy. Case Report	*Edwin Breck Eckerson*	487
Sterilization of the Ovaries by Roentgen Rays in the Treatment of Distant Metastases from Primary Carcinoma of the Breast. Report of Two Cases	*Ernst A. Poble*	490
Iliocolic Intussusception. Diagnosis by *X*-ray without Contrast Media	*Joseph Levitin*	494
Mental Disorders Associated with Hyperthyroidism	*Elbert T. Rulison, Jr.*, *John D. White*, *Leonard K. Stalker*	499
Peritoneoscopy versus Exploratory Laparotomy. A Comparison of Morbidity and Mortality	*Boardman M. Bosworth*	502
Electric Bone Saw and Drill	*J. Vernon Luck*	505
Appendectomy with a Modified Furniss Clamp	*Arthur Bowen*	508
Doyen Tumor Screw. Furniss Modification	*H. D. Furniss*	510
The Carnero. A Fish Parasite of Man and Possibly of Other Mammals	*Kenneth W. Vinton*, *W. Hugh Stickler*	511
Cesarean Section. The Modern Operation	*Charles A. Gordon*, *Alexander H. Rosenthal*	525
Juvenile Osteochondreal (Chondro-Epiphysitis) Hypothyroidism	*Robert L. Schaefer*, *Frank H. Purcell*	589
Bone Drilling in Resistant Chronic Ulcers. A New Principle	*Fred H. Albee*	605
Differential Diagnosis of the "Painful Hip" in Childhood	*Paul C. Colonna*	609
Primary Bronchogenic Carcinoma of the Lung. A Clinical and Roentgen Study of Thirty-eight Cases over a Period of Twelve Years	*Harry A. Olin*, *Clinton A. Elliott*	614
Pathology of Appendiceal Stump with Suggestions for Prophylaxis	*V. L. Schrager*	629
Emergency Control of Postpartum Hemorrhage. Experience with a Supplementary Technic	*Clarence C. Briscoe*, *Robert A. Wilson*	634
Treatment of Pelvic Infection by Iontophoresis of a Choline Compound	*Alexander H. Rosenthal*	639
Surgical Treatment of Axillary Hidrosadenitis Suppurativa	*Harry B. Macey*	643
Postoperative Gastric Drainage. Quantitative Study for an Indication of Re-establishment of Gastrointestinal Motility Following Gastric Operations	*James P. Warbasse, Jr.*	648
Prevention of Postoperative Meningitis by Intracranial Implantation of Powdered Sulfanilamide	*Yale D. Koskoff*, *Norman M. Wall*	653

Biochemical Aspects of Preoperative and Postoperative Treatment. Its Practical Application	*Raymond Green*	659
Peritoneoscopy. With Special Reference to Widening Its Applications	*Joseph E. Hamilton*	668
Healing of the Operative Wound in Syphilitic Women	*Henry C. Falk*, *Ivan Kempner*	674
Congenital Duodenal Obstruction	*Russel O. Lyday*	678
Postoperative Evisceration. Résumé of the Literature and Report of Five Cases	*Morris L. Bobrow*	682
Ultraviolet Irradiation of Autotransfused Blood in the Treatment of Puerperal Sepsis	*E. W. Rebbeck*	691
Treatment of Surgical and Traumatic Shock with a Citrated Plasma-Saline Mixture	*Charles Stanley White*, *J. Lloyd Collins*, *Jacob J. Weinstein*	701
New Operative Procedure for Dupuytren's Contracture	*Elias Lincoln Stern*	711
Preparation of Superficial Wounds for Skin Grafting by the Local Use of Sulfanilamide and Sulfanilamide-Allantoin Ointment	*J. Ross Veal*, *Roy G. Klepser*, *Michael P. DeVito*	716
Use of a Plaster Slipper in the Management of Simple Fractures of the Toes	*Joseph E. Macmanus*	721
Obstruction of the Common Bile Duct by a Detached Piece of Liver	*N. Frederick Hicken*, *J. LeRoy Kimball*	723
Subcutaneous Rupture of Meckel's Diverticulum	*H. A. Gamble*	727
Migration of Projectiles in Blood Vessels. Report of an Unusual Case	*George J. Laird*	729
Multiple Shell Wounds. A Case Report	*Alfred J. Barbano*	731
Avulsion of the Distal Tendon of the Biceps Brachii	*Walter E. Sharpe, Jr.*	733
Pseudofracture of the Tibia. Report of Two Cases	*J. Lloyd Tabb*, *Bernard D. Packer*	737
Recurring Pyogenic Osteomyelitis. Report of a Case with a Forty-seven Year Quiescent Period between Attacks	*Bernard N. E. Cohn*	741
Adenoma of Langerhans' Islet of the Pancreas	*Perry G. Vayo*, *George T. Bodon*	744
Diagnostic Points in Intra-abdominal Pregnancy. Report of a Case	*Morris Weintrob*, *David I. Weintrob*	747
Mobile Cecum with Left Hydrocele. Case Report	*W. Houston Toulson*	753
Dog Surgery. Descriptions of Technic for Anesthesia and of a Respirator for Thoracic Surgery Practice	*Thomas Peck Butcher*, *Clyde O. Merideth, Jr.*	755
Phillip's Recessed Head Screw	*Arch F. O'Donoghue*	758
Elimination of Air Bubbles from Intravenous Apparatus by a Modification of the Murphy Drip	*Edward J. Ottenheimer*	759
Modified Braun Perineal Scissors	*Harold D. Caylor*	760
Cancer of the Gums (Gingivae)	*Hayes Martin*	765

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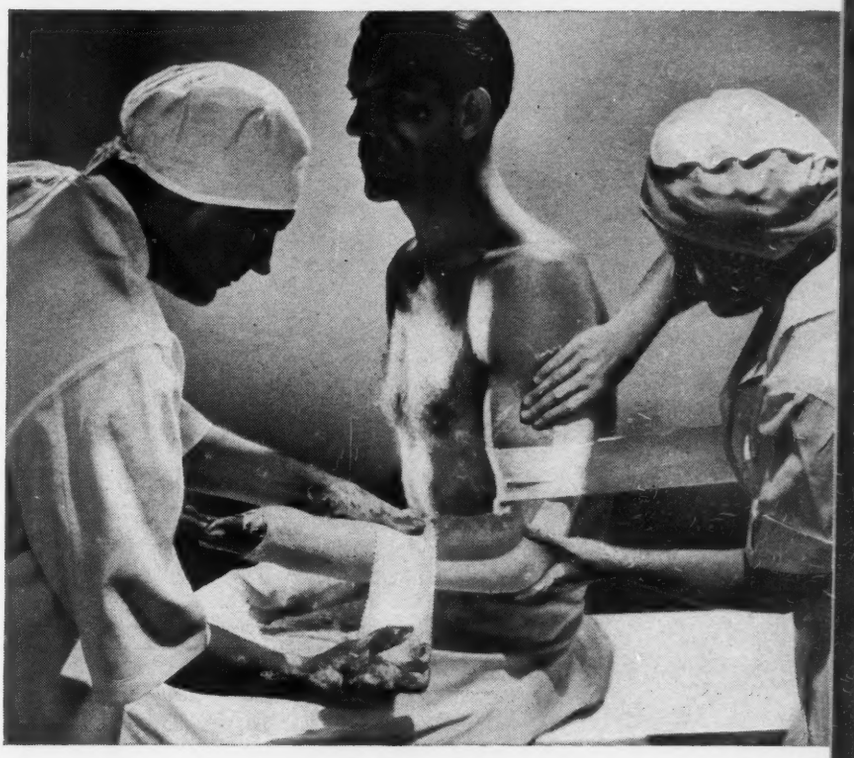

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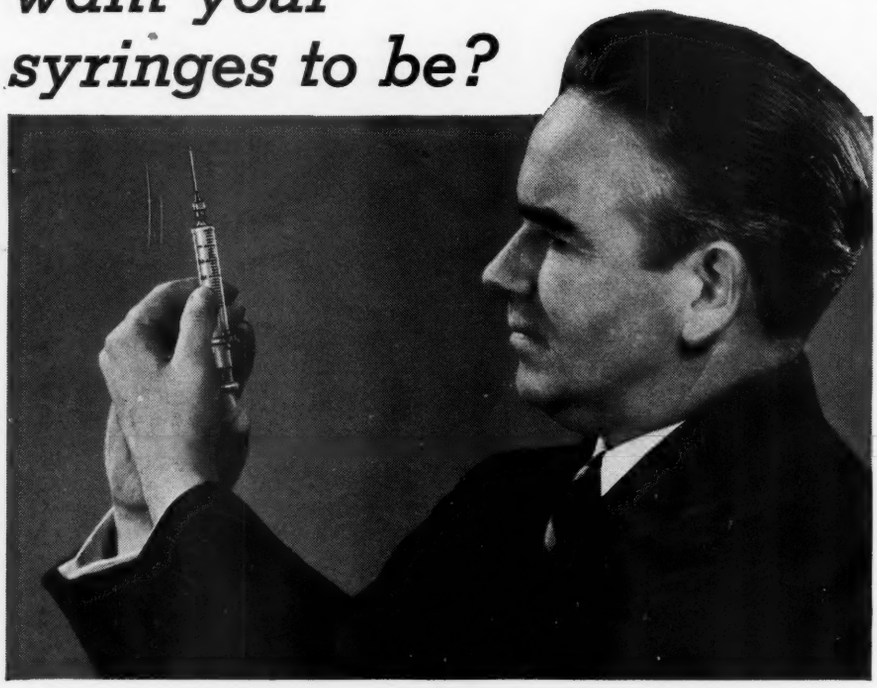

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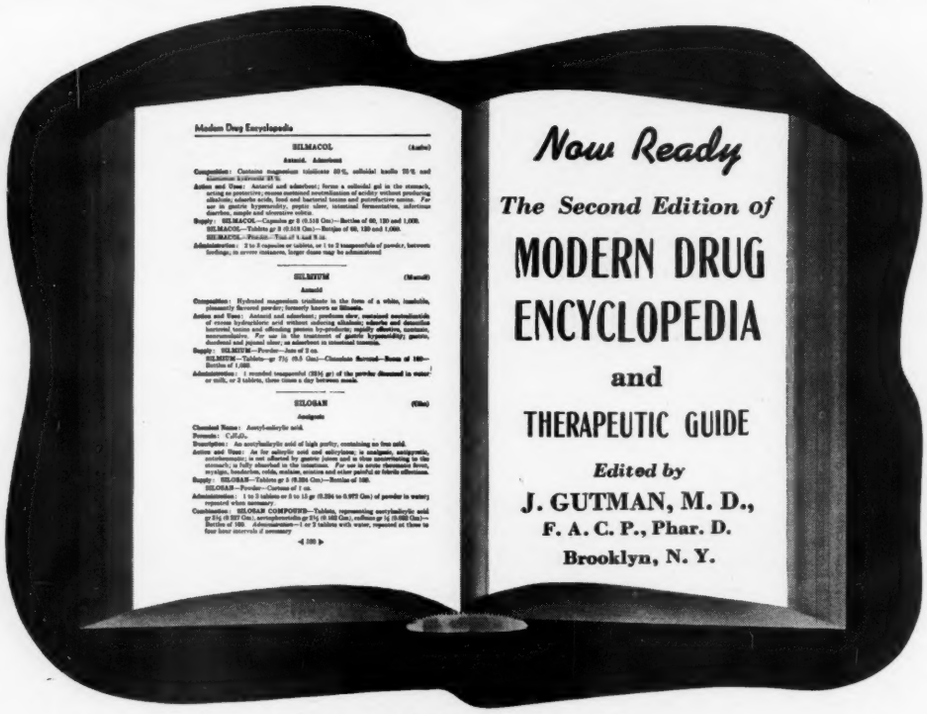

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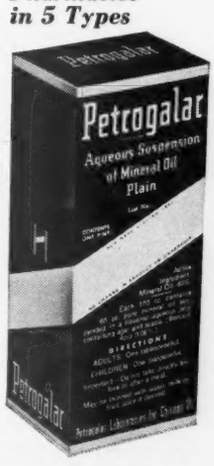

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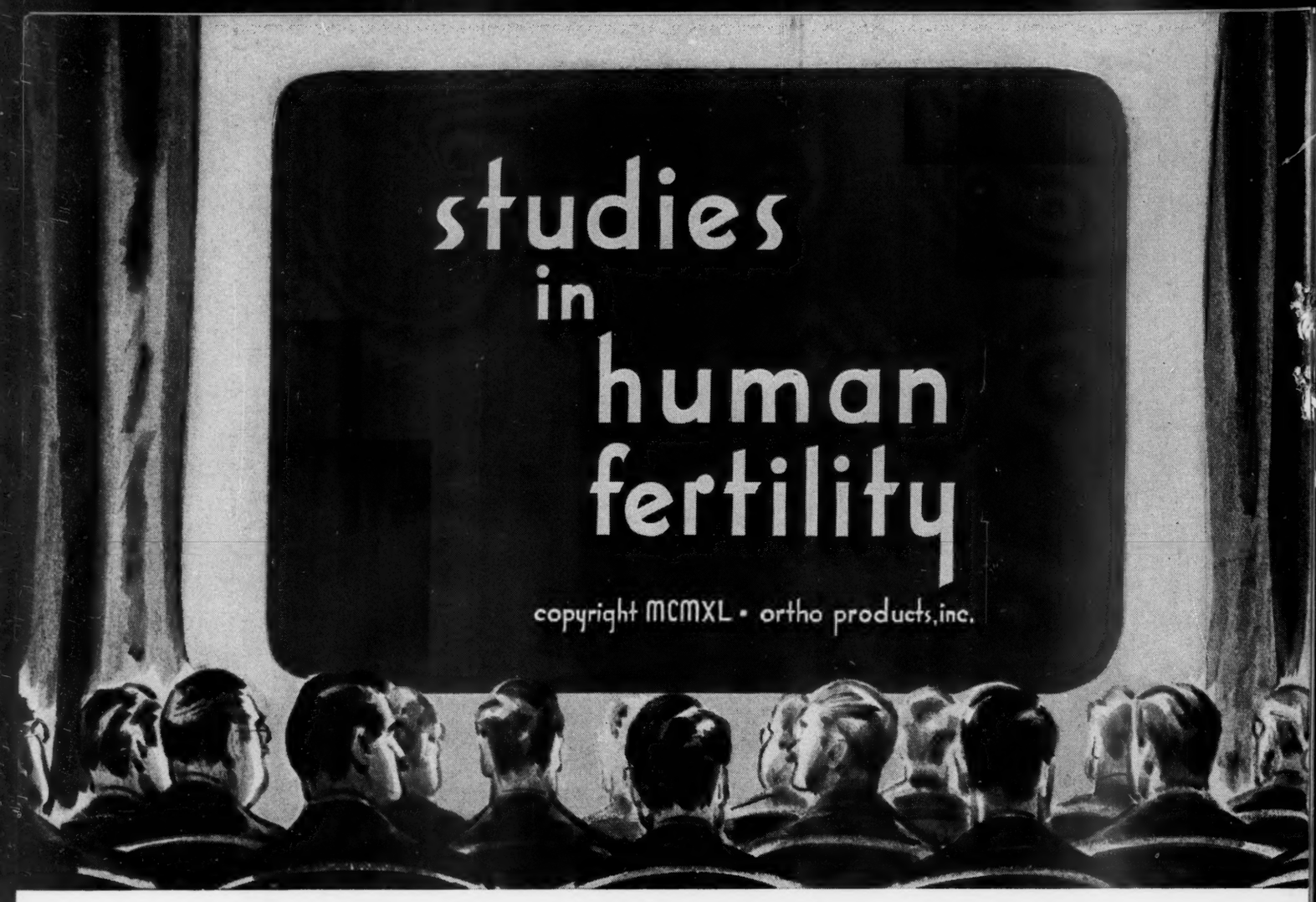

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ADVERTISERS INDEX

Instruments and Apparatus

Austenal Laboratories, Inc.	29
Bard-Parker Co., Inc.	*November*
W. A. Baum Co., Inc.	*November*
Crescent Surgical Sales Co., Inc.	*November*
General Electric X-ray Corp	*November*
Fred Haslam & Co., Inc.	28
Parker, White & Heyl, Inc.	*November*
Picker X-ray Corp	*November*
Geo. P. Pilling & Son Co.	14
J. Sklar Manufacturing Co.	7
Edward Weck & Co., Inc.	5

Sutures

Davis & Geck, Inc.	*Insert facing 2nd Cover*
J. A. Deknatel & Son, Inc.	*November*
Johnson & Johnson	8, 9

Pharmaceuticals

Abbott Laboratories	12
Alba Pharmaceutical Co., Inc.	19
American Hospital Supply Corp.	10
The Arlington Chemical Co.	26
The Armour Laboratories	27
Baxter Laboratories, Inc.	10
Chatham Pharmaceuticals, Inc.	26
Ciba Pharmaceutical Products, Inc.	*4th Cover*
Hoffmann-La Roche, Inc.	2
Hynson, Westcott & Dunning, Inc.	*September*
The Lavoris Company	*November*
Lederle Laboratories, Inc.	*November*
Thos. Leeming & Co., Inc.	1
E. C. Lientz & Co., Inc.	28
Eli Lilly and Company	*November*
Mallinckrodt Chemical Works	*November*
Merck & Co., Inc.	*November*
National Drug Co.	11
Ortho Products, Inc.	34
Parke, Davis & Co.	*November*
Petrogalar Laboratories, Inc.	33
Schering Corporation	13
Schering & Glatz, Inc.	23
E. R. Squibb & Sons	17
Frederick Stearns & Co.	20
The Upjohn Co.	*November*
Wallace & Tiernan Products, Inc.	*November*
Wm. R. Warner & Co., Inc.	15
Winthrop Chemical Co., Inc.	*November*
John Wyeth & Bro., Inc.	*November*

Hospital Supplies

American Hospital Supply Corp.	10
Baxter Laboratories, Inc.	10
Becton, Dickinson & Co.	22
Crescent Surgical Sales Co., Inc.	*November*
Duke Laboratories, Inc.	*November*
General Electric X-ray Corp.	*November*
Fred Haslam & Co., Inc.	28
Johnson & Johnson	21
Macalaster Bicknell Co.	18
Massillon Rubber Co.	*November*
Picker X-ray Corp	*November*
J. Sklar Manufacturing Co.	7

Post-Graduate Instruction

Cook County Grad. Sch. of Med.	25
N. Y. Polyclinic Med. School	25

Foods

Chas. B. Knox Gelatine Co., Inc.	32
The Wander Company	31

Miscellaneous

The American Journal of Surgery	6, 16
General Information	4
Iodine Educational Bureau, Inc.	30
New Modern Drugs	30
Society Meetings	24

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